WADC TECHNICAL REPORT 58-476
VOLUME II

THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS

VOLUME II - ALLOYS

(Melting Temperature above 1000°F)

Alexander Goldsmith
Harry J. Hirschhorn
Thomas E. Waterman

Armour Research Foundation

Revised Edition

NOVEMBER 1960

WRIGHT AIR DEVELOPMENT DIVISION

NOTICES

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Materials Central
Contract No. AF 33(616)-5212
Project No. 7381

WRIGHT AIR DEVELOPMENT DIVISION
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

This compilation of thermophysical property data was prepared by the Heat Transfer Section of the Fluid Dynamics and Systems Research Division of the Armour Research Foundation, Chicago, Illinois, under USAF Contract No. AF 33(616)-5212. This contract was initiated under Project No. 7381, "Thermophysical Data Consolidation", Task No. 73812, "Thermophysical Data for Solid Materials". The program was administered by the Materials Laboratory, Directorate of Laboratories, Wright Air Development Division, and directed by Jules I. Wittebort, Chief, Thermophysics Branch.

These volumes cover work carried out from 1 July 1957 to 31 August 1960. The Materials Index, given in the forward portion of this volume, was arranged with the advice of W. H. Colner, S. W. Bradstreet and J. S. Griffith of the Ceramics Research Division.

The literature search was conducted by the staff of the Technical Information Research Section.

The study, evaluation, and compilation phases were carried out by the following personnel of the Heat Transfer Section: W. A. Gans, A. Goldsmith, J. I. Lang, H. J. Hirschhorn, and T. E. Waterman.

Computation, reading of published graphs, and plotting of data for this publication was done by D. Brast, G. Buzyna, M. Deahl, S. Chmel, A. Karazija, T. Schmugge, and a number of others.

The bulk of the typing of reproducible copy was done by Mrs. Mary A. Scroll.

The authors are particularly grateful to Mr. I. B. Fieldhouse, Supervisor of the Heat Transfer Section, for his guidance and encouragement and to Mr. S. W. Bradstreet, Supervisor of Inorganic Technology for his aid in the area of Ceramics.

The entire effort at the Armour Research Foundation was directed by Alexander Goldsmith, project engineer.

ABSTRACT

Thermophysical property data, and their variation with temperature, are presented for a great number of solid materials, based on literature published during the period 1940-1957. Each reported value is shown and annotated, and recommended "most probable value" curves are given.

Materials covered include Elements, Alloys, Ceramics, Cermets, Intermetallics, Polymerics, and Composite Materials. Except for materials in the last two categories, only those melting above 1000°F are included.

Properties covered include the following: Melting point, density, latent heats, specific heat, thermal conductivity, thermal diffusivity, emissivity, reflectivity, thermal expansion, vapor pressure, and electric resistivity.

Each of the four volumes is designed to be expansible, and it is expected that additional or revised data sheets for inclusion in these volumes will be forthcoming.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

Jules I. Wittebort

JULES I. WITTEBORT
Chief, Thermophysics Branch
Physics Laboratory
Materials Central

THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS

I. INTRODUCTION

At the initiative of the Materials Laboratory, Wright Air Development Center, and under its sponsorship, a program was undertaken to compile, evaluate, and consolidate all original test data on thermophysical properties of solid materials published during the period 1940-1957 inclusive. This publication contains the accumulated information and represents three years of effort. The data are presented in four volumes, divided as follows:

1. Elements
2. Alloys
3. Ceramics
4. Cermets, Intermetallics, Polymerics, and Composites

Each volume is designed to be expansible so that it will lend itself to the inclusion of new data as well as to the substitution of others. Additional data sheets for inclusion in these volumes will be published when available.

The collected data were obtained from a search of the following sources: (a) Chemical Abstracts, (b) Ceramic Abstracts, (c) Metallurgical Abstracts, (d) Nuclear Science Abstracts, and (e) Armed Services Technical Information Agency (ASTIA).

A detailed description of contents and of the method of presentation of data is given in the following several pages.

II. MATERIALS

Materials included in this survey are those which may find application in the design of aircraft, missiles, space vehicles, conventional or nuclear power plants, or allied equipment. Generally, only materials melting above 1000°F are included; exceptions are limited to the categories of plastics or composite materials. A listing of materials covered in the literature search is given in the Materials Index, which is described in Section IV-A below. This index also serves as a guide to the arrangement of data, and as a page numbering system. Due to the lack of published data, some of the materials listed in the index may not be represented by data sheets.

Manuscript released by authors 30 June 1960 for publication as a WADC Technical Report.

III. PROPERTIES

Physical properties included in this survey are the following:

Property	Symbol
1. Density	ρ
2. Melting Point	M. P.
3. Latent Heat of Fusion	Δh_f
4. Latent Heat of Vaporization	Δh_v
5. Latent Heat of Sublimation	Δh_s
6. Specific Heat (constant pressure)	c_p
7. Thermal Conductivity	k
8. Thermal Diffusivity	α
9. Emissivity, Reflectivity	ϵ, R
10. Linear Thermal Expansion	$\Delta L/L$
11. Vapor Pressure	p
12. Electric Resistivity	r

The first five properties in the above list are given as single point values, in individual tables grouped on a single sheet. The others are presented graphically as functions of temperature. All data on linear thermal expansion have been reduced to a datum of 20°C; i.e. $\Delta L/L = 0$ at 528°R (293°K).

IV. CONTENTS

Each of the four volumes of data consists of four sections arranged in the following order:

1. Introductory remarks and explanatory text
2. Materials Index
3. Tables of Conversion Factors
4. Body of Data

The fifth volume, or Appendix, consists of the following sections:

1. Introductory remarks and explanatory text
2. Materials Index
3. List of References
4. Author Index (alphabetic)

A. Materials Index

The Materials Index, located in the front portion of each volume following these introductory pages, gives the order in which the body of data is arranged. It is based, with few exceptions, on the chemical composition of materials, and is arranged in outline fashion. It can have four orders of subdivision designated by Roman numerals, capital letters, common numerals and lower case letters such as:

I.
  A.
    1.
      a.

Each category, even in the lowest order, represents a family of materials, rather than a specific one, so that the number of individual materials that can be accommodated is virtually unlimited. The index lends itself to future expansion.

B. Body of Data

The body of data is arranged by materials in the order of the Materials Index. Properties for a given small family of materials are given in the order listed in Section III above. Each plotted point or numerical value in the body of data is identified as to source by reference to the List of References.

C. List of References

The List of References gives complete bibliographic notations for all the references from which usable data have been extracted. These are arranged chronologically by year of publication, and in an arbitrary sequence within any given year.

D. Author Index

The Author Index is arranged in alphabetic order by author's surname. Coauthors are also included. Each entry is cross-referred to the List of References where a complete bibliographic notation is given.

V. METHOD OF PRESENTATION OF DATA

A. Format

A "unit" of information in this volume consists of a single sheet having a graph on one face and reference information on the back. The first five properties listed in Section III above are referred to as "point values" and are grouped together as a "unit" on a single sheet in the same manner as a graph.

B. Pagination

Each volume is designed to be expansible, and therefore is not compatible with conventional page numbering. The system adopted is as follows:

The body of data is arranged by materials in accordance with the Materials Index which is located in the forward portion of each volume. Furthermore, for a given small family of materials, data for the several properties are arranged in accordance with the listing given in Section III above. The Materials Index designation is given in the lower right corner of each graph or data sheet in lieu of a page number. This identification is not unique since several materials of the same family carry the same designation, but it guides the reader to the approximate location of the desired information.

Materials that do not fit into any subgroup presently listed in the Materials Index are designated by the next higher order grouping.

Example: Nickel-Silicon alloys are not specifically identified as a family grouping in the Materials Index. These therefore, are designated by the next higher order of subdivision, namely, Nickel-Base Alloys, category IV-A in the index.

Data for such materials are located at the end of the group; that is, after those materials which do fit into a currently identified subgroup. Within this framework, where necessary, data sheets are further arranged in alphabetic order by the major alloying element. It is expected that after the initial familiarization with this arrangement, the user will be able to locate the desired information (or convince himself of its absence) with a minimum of page-by-page searching.

A unique identification of each sheet is provided by the number in the lower left corner of the sheet. The initial two digits of this number give the year when the sheet was prepared; the latter digits are merely a numerical sequence for identification purposes only and serve no other purpose.

C. Graph Sheets

Data extracted from various references on the same subject (material and property) are identified on each graph by means of distinctive plotting symbols. These sysbols indicate the data of a given investigator, but do not necessarily imply actual test points. In numerous instances in the literature an author presents only smoothed data, either graphically or in tabular form, and it is frequently impossible to distinguish these from actual test values.

In presenting data on thermal expansion, an investigator sometimes gives only a coefficient of expansion for a considerable temperature range. In such instances it is assumed that a linear relationship is implied, and in plotting such data the straight line may be indicated by more than the two end-points in order that the given investigator's data not be obscured by those of others.

With regard to specific heat, some investigators present only total heat content of the material above a given datum, and make no attempt to reduce such data to specific heat. In such instances the investigator's enthalpy data were fitted with a quadratic equation of the form $\Delta H = A + BT + CT^2$ using a least-mean-square procedure to determine the coefficients. This equation was then differentiated with respect to temperature to obtain a linear variation of specific heat with temperature. Instances where this was done are so indicated.

Curves drawn through the plotted points are deemed "most probable value" curves based on the data presented. As additional information from other investigators is added in the future, it may be necessary to modify these curves.

D. Point Values

The first five properties listed in Section III above are considered point functions(at standard temperature and pressure unless indicated otherwise) and are grouped in individual tables, by property, on a single sheet. Data extracted from various references are identified by distinctive plotting symbols in the same manner as points on a graph. "Most probable values", usually based only on the data presented, are given at the top of the page. In some instances where data were not available from the current survey, density and melting point information was taken from secondary (nonoriginal) sources. These appear only at the top of the sheet and are identified as to source. Melting points of binary alloys, representing the solidus line on a phase diagram, have generally not been included. Many of these are given by Hansen and Anderko in "Constitution of Binary Alloys" (Ref. 58-11).

E. Reference Information

1. Symbol

The plotting symbols are identical with, and correspond to those used on the face of a given graph or data sheet.

2. Investigator

The investigator, or author, of each reference is identified by name. Coauthors are included.

3. Reference

References are identified by hyphenated numbers such as 00-00, which serve to locate the bibliographic entry for the given source in the List of References in the Appendix. The initial two digits indicate the year of publication. The remaining number locates the specific reference within the given year.

Example: Ref. 54-7 is found in the List of References under the year 1954; the seventh entry of that year. It is an article by R. W. Powell entitled "The Thermal Conductivity of Beryllia".

References which are not dated are identified with the letters ND in place of the year of publication, such as ND-00. Undated references are listed at the end of the List of References.

4. Range

The column marked "Range, °R" indicates the temperature range covered by the data in the given reference.

5. Material Composition

This column contains any pertinent information given in a reference that serves to describe the material investigated. Primarily this consists of the chemical composition of the material, its purity, density, and common trade name when given. Where a material was identified by trade name only, the nominal composition was added.

6. Test Method

A general indication of the test method used by the investigator is given in this column. While test methods for a given property can be reasonably grouped into several broad categories, each investigator makes his own modifications and alterations which do not lend themselves to brief description.

7. Remarks

Pertinent remarks concerning the given data are included in this column. Such remarks may describe a prior treatment of the material, the environment during the test, the author's estimate of accuracy, or similar information.

MATERIALS INDEX

MAJOR HEADINGS

MATERIALS INDEX

I. ELEMENTS (Melting temperature above 1000° F)

	Element	Symbol
I - A - 1	Actinium	Ac
I - A - 2	Aluminum	Al
I - A - 3	Americium	Am
I - A - 4	Antimony	Sb
I - A - 5	Arsenic	As
I - A - 6	Astatine	At
I - B - 1	Barium	Ba
I - B - 2	Berkelium	Bk
I - B - 3	Beryllium	Be
I - B - 4	Boron	B
I - C - 1	Calcium	Ca
I - C - 2	Californium	Cf
I - C - 3	Carbon	C

a. Extruded Acheson graphite, multicrystalline
b. Extruded Acheson amorphous carbon
c. Extruded Acheson graphite, impregnated
d. Molded Acheson graphite, multicrystalline
e. Molded Acheson amorphous carbon
f. Molded Acheson graphite, impregnated
g. Lampblack - base carbon or graphite
h. Pyrolytic graphite
j. Natural graphite-base graphite
k. Natural graphite-base carbon
m. Diamond
n. Single crystal graphite
p. Lampblacks

I - C - 4	Cerium	Ce
I - C - 5	Chromium	Cr
I - C - 6	Cobalt	Co
I - C - 7	Copper	Cu
I - C - 8	Curium	Cm
I - D - 1	Dysprosium	Dy
I - E - 1	Einsteinium	E
I - E - 2	Erbium	Er
I - E - 3	Europium	Eu
I - F - 1	Fermium	Fm
I - F - 2	Francium	Fr

I. ELEMENTS (Continued)

	Element	Symbol
I - G - 1	Gadolinium	Gd
I - G - 2	Germanium	Ge
I - G - 3	Gold	Au
I - H - 1	Hafnium	Hf
I - H - 2	Holmium	Ho
I - J - 1	Iridium	Ir
I - J - 2	Iron	Fe
I - L - 1	Lanthanum	La
I - L - 2	Lutetium	Lu
I - M - 1	Magnesium	Mg
I - M - 2	Manganese	Mn
I - M - 3	Mendelevium	Mv
I - M - 4	Molybdenum	Mo
I - N - 1	Neodymium	Nd
I - N - 2	Neptunium	Np
I - N - 3	Nickel	Ni
I - N - 4	Niobium (Columbium)	Nb
I - N - 5	Nobelium	No
I - O - 1	Osmium	Os
I - P - 1	Palladium	Pd
I - P - 2	Platinum	Pt
I - P - 3	Plutonium	Pu
I - P - 4	Polonium	Po
I - P - 5	Praseodymium	Pr
I - P - 6	Promethium	Pm
I - P - 7	Protactinium	Pa
I - R - 1	Radium	Ra
I - R - 2	Rhenium	Re
I - R - 3	Rhodium	Rh
I - R - 4	Ruthenium	Ru
I - S - 1	Samarium	Sm
I - S - 2	Scandium	Sc
I - S - 3	Silicon	Si
I - S - 4	Silver	Ag
I - S - 5	Strontium	Sr

I. ELEMENTS (Continued)

	Element	Symbol
I - T - 1	Tantalum	Ta
I - T - 2	Technetium	Tc
I - T - 3	Terbium	Tb
I - T - 4	Thorium	Th
I - T - 5	Thulium	Tm
I - T - 6	Titanium	Ti
I - T - 7	Tungsten	W
I - U - 1	Uranium	U
I - V - 1	Vanadium	V
I - Y - 1	Ytterbium	Yb
I - Y - 2	Yttrium	Y
I - Z - 1	Zirconium	Zr

II. IRON BASE ALLOYS

(Iron greatest weight fraction with one or more other elements.)

A. Plain Carbon Steels ($Mn < 2.5\%$; $Si < 0.36\%$; P, $S < 0.051\%$ each)

1. $0.02 < C \leq 0.20\%$
2. $0.20 < C \leq 0.40\%$
3. $0.40 < C \leq 0.60\%$
4. $0.60 < C \leq 0.80\%$
5. $0.80 < C \leq 1.00\%$
6. $1.00 < C \leq 1.20\%$
7. $1.20 < C \leq 1.50\%$
8. $1.50 < C \leq 2.00\%$

B. Cast Irons

1. Gray, unalloyed and low alloy (Less than 2% total alloying elements exclusive of C, $Mn < 1\%$, Si, P, S)

2. Gray, alloyed (More than 2% total alloying elements exclusive of C, $Mn < 1\%$, Si, P, S)

3. White, unalloyed and low alloy (Less than 2% total alloying elements exclusive of C, $Mn < 1\%$, Si, P, S)

4. White, alloyed (More than 2% total alloying elements exclusive of C, $Mn < 1\%$, Si, P, S)

5. Malleable, Ferritic

6. Malleable, Pearlitic

7. Nodular, Ferritic

8. Nodular, Pearlitic

II. IRON-BASE ALLOYS (Continued)

C. Low Alloy Steels (Less than 10% of any single alloying element, exclusive of C; Mn < 2.5%; Si < 0.36%; P, S < 0.051% each. Alloying elements listed in decreasing order of their weight fractions. X may be none, one, or more elements; $X = X_1 + X_2 + \ldots$)

1. Fe + Ni
2. Fe + Ni + Cr + X
3. Fe + Ni + Mo + X
4. Fe + Ni + X ($X_1 \neq$ Mo, Cr)
5. Fe + Mo + X
6. Fe + Cr + X ($X_1 \neq$ Mo)
7. Fe + Cr + Mo + X
8. Fe + W + X
9. Fe + Si + X

D. High Alloy Steels (More than 10% of any single alloying element exclusive of C; Mn < 2.5%; Si < 1.00%; P, S < 0.051% each. Alloying elements listed in decreasing order of their weight fraction. X may be none, one, or more elements; $X = X_1 + X_2 + \ldots$)

1. Fe + Cr
2. Fe + Cr + Ni
3. Fe + Cr + Ni + X ($X_1 \neq 0$)
   a. Fe + Cr + Ni + Co + X
4. Fe + Cr + X ($X_1 \neq 0$, Ni)
5. Fe + Ni
6. Fe + Ni + X ($X_1 \neq 0$)
   a. Fe + Ni + Cr + X
7. Fe + Al + X
8. Fe + W + X
9. Fe + Mn + X

III. COPPER-BASE ALLOYS

(Copper greatest weight fraction with one or more other elements. Alloying elements listed in decreasing order of their weight fractions. X may be none, one, or more elements.)

A. Copper + Zinc + X

1. Cu + Zn + Pb + X
2. Cu + Zn + Sn + X
3. Cu + Zn

B. Copper + Tin + X

1. Cu + Sn + Pb + X
2. Cu + Sn + Zn + X
3. Cu + Sn

C. Copper + Lead + X

D. Copper + Nickel + X

E. Copper + Aluminum + X

F. Copper + Silicon + X

G. Copper + Beryllium + X

H. Copper + Manganese + X

J. Copper + Tellurium + X

K. Copper + Chromium + X

L. Copper + Zirconium + X

IV. NICKEL-BASE, COBALT-BASE, AND REFRACTORY METAL-BASE ALLOYS

(Major element greatest weight fraction with one or more other elements. Alloying elements listed in decreasing order of their weight fractions. X may be none, one, or more elements.)

A. Nickel-Base Alloys

1. Ni + Cu + X
2. Ni + Mo + X
3. Ni + Co + X
    a. Ni + Co + Cr + X
4. Ni + Fe + X
    a. Ni + Fe + Cr + X
5. Ni + Cr + X
    a. Ni + Cr + Fe + X
6. Ni + Mn + X

B. Cobalt-Base Alloys

1. Co + Cr + X
2. Co + Ni + X
3. Co + Fe + X
4. Co + Pd + X

C. Tungsten-Base Alloys

D. Molybdenum-Base Alloys

E. Niobium-Base Alloys

F. Chromium-Base Alloys

1. Cr + Ni + X
2. Cr + Mo + X

G. Vanadium-Base Alloys

H. Tantalum-Base Alloys

J. Zirconium-Base Alloys

1. Zr + Sn + X
2. Zr + Nb + X
3. Zr + U + X

K. Hafnium-Base Alloys

L. Thorium-Base Alloys

V. LIGHT METAL ALLOYS (Including Ti Alloys)

(Major element greatest weight fraction with one or more other elements. Alloying elements listed in decreasing order of their weight fractions. X may be none, one, or more elements; $X = X_1 + X_2 + \ldots$)

A. Aluminum-Base Alloys

1. Al + Cu + X
2. Al + Si + X
   a. Al + Si + Cu + X
   b. Al + Si + Mg + X
3. Al + Mg + X
4. Al + Zn + X
5. Al + Mn + X
6. Al + Ag + X

B. Magnesium-Base Alloys

1. Mg + Al + Zn + X
2. Mg + Al + X ($X_1 \neq$ Zn)
3. Mg + Rare Earth + X
4. Mg + Th + X
5. Mg + Li + X
6. Mg + Zn + X

C. Titanium-Base Alloys

1. Ti + Al + X
2. Ti + Mn + X
3. Ti + Mo + X
4. Ti + V + X
5. Ti + Cr + X
6. Ti + Fe + X ($X_1 \neq$ Cr)
7. Ti + Fe + Cr + X
8. Ti + O + X

D. Beryllium-Base Alloys

VI. OTHER METAL ALLOYS, melting temperature above 1000°F

(Major element greatest weight fraction with one or more other elements. Alloying elements listed in decreasing order of their weight fractions. X may be none, one, or more elements.)

A. Gold-Base Alloys

1. Au + Cd + X
2. Au + Co + X
3. Au + Pd + X
4. Au + Ni + X
5. Au + Mn + X

B. Silver-Base Alloys

1. Ag + Al + X
2. Ag + Cd + X
3. Ag + Cu + X
4. Ag + Pd + X

C. Platinum-Base Alloys

D. Palladium-Base Alloys

1. Pd + Au + X
2. Pd + Co + X
3. Pd + Cu + X

E. Manganese-Base Alloys

1. Mn + Cu + X
2. Mn + Ni + X

F. Uranium-Base Alloys

1. U + Cr + X
2. U + Mo + X
3. U + Zr + X

G. Silicon-Base Alloys

1. Si + Fe + X

VII. CERAMICS

A. Oxide Ceramics (Nominal oxide; or nominal oxide greatest weight fraction with one or more other oxides. X may be none, one, or more oxides. Also see VII-B and VII-E.)

1. Aluminum Oxide + X

    a. Aluminum oxide (alumina, corundum, sapphire)
    b. Aluminum oxide + Chromium oxide + X

2. Beryllium Oxide + X

    a. Beryllium oxide (beryllia, bromellite)

3. Calcium Oxide + X

    a. Calcium oxide (calcia, lime)

4. Rare Earth Oxides (Atomic Numbers 57-71 in Alphabetic Order)

    a. Cerium oxide + X (ceria)
    b. Dysprosium oxide + X (dysprosia)
    c. Erbium oxide + X (erbia)
    d. Europium oxide + X (europia)
    e. Gadolinium oxide + X (gadolinia)
    f. Holmium oxide + X
    g. Lanthanum oxide + X (lanthana)
    h. Lutetium oxide + X
    j. Neodymium oxide + X (neodymia)
    k. Praseodymium oxide + X (praseodymia)
    m. Promethium oxide + X
    n. Samarium oxide + X (samaria)
    p. Terbium oxide + X (terbia)
    q. Thulium oxide + X (thulia)
    r. Ytterbium oxide + X (ytterbia)

5. Magnesium Oxide + X

    a. Magnesium oxide (magnesia, periclase)

6. Silicon Oxide + X (silica, crystobalite, quartz; see also VII-C-6)

7. Thorium Oxide + X (thoria, thorianite)

8. Titanium Oxide + X (anatase, brookite, rutile)

9. Hafnium Oxide + X; Zirconium Oxide + X

    a. Hafnium oxide (hafnia)
    b. Zirconium oxide (zirconia)

VII. CERAMICS (Continued)

A. Oxide Ceramics (Continued)

10. Uranium Oxide + X

11. Plutonium Oxide + X

12.

13. Other Oxide Ceramics, in Alphabetic Order: A-I

14. Other Oxide Ceramics, in Alphabetic Order : J-R

15. Other Oxide Ceramics, in Alphabetic Order: S-Z

B. Mineral Ceramics (Also see VII-A and VII-E)

1. Aluminosilicates, non-hydrous (mullite, kyanite, sillimanite)

2. Silicates of Ba, Be, Ca, Fe, Mg, Mn, Ni, Sr, and Zn in order listed.

3. Alkali and alkaline-earth aluminosilicates (feldspars)

   a. Barium-modified feldspar
   b. Beryllium-modified feldspar (beryl)
   c. Calcium-modified feldspar
   d. Cesium-modified feldspar
   e. Lithium-modified feldspar
   Magnesium aluminosilicate, see VII-E-3
   f. Potassium feldspar
   g. Rubidium feldspar
   h. Sodium feldspar
   j. Strontium-modified feldspar

4. Hafnium silicate; Zirconium silicate

   a. Hafnium silicate (hafnon)
   b. Zirconium silicate (zircon)

5. Borates (borax, colemanite); Phosphates

VII. CERAMICS (Continued)

B. Mineral Ceramics (Continued)

6. Hafnates; Niobates; Titanates; Zirconates

a. Hafnates
b. Niobates
c. Zirconates
d. Aluminum titanate
e. Barium titanate
f. Calcium titanate
g. Iron titanate
h. Lithium titanate
j. Magnesium titanate
k. Strontium titanate
m. Zinc titanate
n. Zirconium titanate

7. Aluminates

a. Magnesium aluminate (spinel)
b. Barium aluminate
c. Beryllium aluminate
d. Calcium aluminate
e. Cesium aluminate
f. Lithium aluminate
g. Potassium aluminate
h. Rubidium aluminate
j. Sodium aluminate
k. Strontium aluminate
m. Zinc aluminate

8. Ferrites

a. Magnesium ferrite
b. Barium ferrite
c. Beryllium ferrite
d. Calcium ferrite
e. Cesium ferrite
f. Lithium ferrite
g. Potassium ferrite
h. Rubidium ferrite
j. Sodium ferrite
k. Strontium ferrite
m. Cobalt ferrite
n. Nickel ferrite
p. Zinc ferrite

9. Micas (Illites)

10. Asbestos minerals

VII. CERAMICS (Continued)

C. Vitreous Structures

1. Silicate glasses

   a. Lithium silicate glass
   b. Sodium silicate glass
   c. Potassium silicate glass
   d. Rubidium silicate glass
   e. Cesium silicate glass
   f. Beryllium silicate glass
   g. Magnesium silicate glass
   h. Calcium silicate glass
   j. Strontium silicate glass
   k. Barium silicate glass
   m. Lead silicate glass

2. Borate glasses

3. Phosphate glasses

4. Arsenic oxide glasses

5. Borosilicate glasses (pyrex)

6. Silica glasses (fused quartz)

D. Covalent Ceramic Structures (Also see Section IX)

1. Silicon carbide + X

   a. Silicon carbide
   b. Silicon carbide + Boron carbide + X

2. Boron carbides

3. Alkali and alkaline earth carbides

   a. Beryllium carbide

4. Boron nitrides

5. Halides and oxyhalides

   a. Fluorides

6. Sulfides; Selenides

VII. CERAMICS (Continued)

E. Vitreous Bonded Crystalline Ceramics (conventional ceramics; also see VII-A and VII-B)

1. Alkaline earth silicate glass bond

2. Alkali silicate glass bond

3. Magnesium aluminosilicate glass bond (cordierite, steatite, talc body)

   a. Lithium modified
   b. Sodium modified
   c. Potassium modified
   d. Rubidium modified
   e. Cesium modified
   f. Beryllium modified
   g. Calcium modified
   h. Strontium modified
   j. Barium modified
   k. Lead modified

4. Calcium aluminosilicate glass bond (porcelain)

5. Other alkaline earth aluminosilicates glass bond

6. Alkali aluminosilicate glass bond

7. Borosilicate glass bond

8. Phosphate glass bond

9. Alumina firebrick

10. Basic brick

11. Silica brick

F. Inorganic Cements and Adhesives

VIII. CERMETS

(Nominal refractory phase is that which is greatest weight fraction of total refractory phase.)

A. Cermets Containing Carbides as Major Refractory Phase

1. Tungsten carbide as major refractory phase
2. Titanium carbide as major refractory phase
3. Chromium carbide as major refractory phase
4. Hafnium carbide or Zirconium carbide as major refractory phase
5. Silicon carbide as major refractory phase

B. Cermets Containing Oxides or Suboxides as Major Refractory Phase

1. Aluminum oxide as major refractory phase
2. Magnesium oxide as major refractory phase
3. Uranium oxide as major refractory phase
4. Thorium oxide as major refractory phase
5. Beryllium oxide as major refractory phase

C. Cermets Containing Borides as Major Refractory Phase

1. Zirconium boride as major refractory phase

D. Cermets Containing Silicides as Major Refractory Phase

E. Cermets Containing Nitrides as Major Refractory Phase

F. Cermets Containing Hydrides as Major Refractory Phase

IX. INTERMETALLICS

(Nominal intermetallic, or nominal intermetallic greatest weight fraction with one or more other intermetallics. Also see section VII - D and respective alloy system.)

A. Carbide Systems

1. Tungsten carbide
2. Titanium carbide
3. Chromium carbide
4. Hafnium carbide; Zirconium carbide
5. Tantalum carbide
6. Molybdenum carbide
7. Uranium carbide

B. Silicide Systems

1. Molybdenum silicide
2. Uranium silicide

C. Boride Systems

1. Magnesium boride
2. Titanium boride
3. Zirconium boride

D. Nitride Systems

1. Titanium nitride
2. Uranium nitride
3. Zirconium nitride

E. Hydride Systems

1. Lithium hydride
2. Zirconium hydride

F. Antimonide, Arsenide, Phosphide, Telluride Systems

1. Antimonides
2. Tellurides

IX. INTERMETALLICS (Continued)

G. Intermetallics Involving a Light Metal (Al, Be, Mg, Ti)

1. Aluminides
2. Beryllides
3. Magnesium intermetallics
4. Titanium intermetallics

H. Intermetallics Involving a Rare Earth

J. Intermetallics Involving a Refractory Metal

1. Chromium intermetallics
2. Cobalt intermetallics
3. Hafnium intermetallics
4. Molybdenum intermetallics
5. Nickel intermetallics
6. Niobium intermetallics
7. Tantalum intermetallics
8. Thorium intermetallics
9. Tungsten intermetallics
10. Vanadium intermetallics
11. Zirconium intermetallics

For intermetallics not listed above, see respective alloy system.

X. POLYMERIC MATERIALS (Including plastics and filled plastics)

A. Polyesters

1. Cellulose acetate
2. Cellulose propionate
3. Cellulose acetate butyrate
4. Cellulose nitrate
5. Ethyl cellulose
6. Polyvinyl acetals
7. Polyvinyl acetate
8. Copolyvinyl chloride-acetate
9. Isocyanates
10. Polyurethanes
11. Unsaturated polyesters

B. TAC Polyesters (tri-allyl cyanurate)

C. Phenolics

1. Phenol formaldehyde
2. Furfural formaldehyde
3. Urea formaldehyde

D. Epoxides

E. Melamines

F. Acrylics

G. Polyethylene and halogenated polyethylenes

H. Polyamide (nylon)

J. Natural and Synthetic Rubber

XI. COMPOSITE MATERIALS

(The word "ceramic", as used below, includes any material which is inorganic and nonmetallic. Semiorganic materials, such as silicones, are included in the term "organic".)

A. Composite Organic Materials; Sandwich Structures. (Any layer may be pure, filled, or reinforced.)

1. Plastic skin, plastic foam core
2. Plastic skin, plastic honeycomb core
3. Solid plastic layers

B. Composite Metallic Materials

1. Metal skin, metal honeycomb core
2. Unbonded metal layers
3. Fusion bonded metal layers
4. Mechanically bonded metal layers
5. Clad metals
6. Plated metals

C. Composite Ceramic Materials

D. Composite Organic - Metallic Materials; Sandwich Structures. (Any organic layer may be pure, filled, or reinforced.)

1. Plastic skin, metal honeycomb core
2. Metal skin, plastic honeycomb core
3. Metal skin, plastic foam core
4. Adhesive bonded metal layers

E. Composite Metallic - Ceramic Materials

F. Composite Organic - Ceramic Materials; Sandwich Structures. (Any organic layer may be pure, filled, or reinforced.)

G. Composite Organic - Metallic - Ceramic Materials; Sandwich Structures. (Any organic layer may be pure, filled, or reinforced.)

XI. COMPOSITE MATERIALS (Continued)

H. Reinforced Organic Materials

1. Reinforced teflon
2. Reinforced melamine formaldehyde
3. Reinforced phenolics
4. Reinforced diallyl phthalate
5. Reinforced polyesters and TAC polyesters
6. Reinforced silicones
7. Reinforced epoxides

J. Reinforced Ceramic Materials

CONVERSION FACTORS FOR DENSITY

	g/cm^3	g/in^3	kg/m^3	kg/ft^3	lb/in^3	lb/ft^3
1 g/cm^3 =	1	16.38716	10^3	28.3170	0.0361275	62.4283
1 g/in^3 =	0.0610234	1	61.0234	1.728	2.20462×10^{-3}	3.80959
1 kg/m^3 =	10^{-3}	0.01638716	1	0.0283170	3.61275×10^{-5}	0.0624283
1 kg/ft^3 =	0.0351446	0.578704	35.31446	1	1.275824×10^{-3}	2.20462
1 lb/in^3 =	27.6797	453.592	27679.7	783.808	1	1728
1 lb/ft^3 =	0.01601837	0.262496	16.01837	0.453592	5.78704×10^{-4}	1

These tables are based on conversion factors given in "Tables of Thermal Properties of Gases", National Bureau of Standards Circular 564, November 1, 1955.

CONVERSION FACTORS FOR SPECIFIC HEAT

	cal/g °K	$\frac{\text{joules}}{\text{g °K}}$	$\frac{\text{watt sec}}{\text{g °K}}$	Btu/lb °R
1 cal/g °K =	1	4.184	4.184	0.999346
1 $\frac{\text{joules}}{\text{g °K}}$ =	0.239006	1	1	0.238849
1 $\frac{\text{watt sec}}{\text{g °K}}$ =	0.239006	1	1	0.238849
1 Btu/lb °R=	1.000654	4.18674	4.18674	1

CONVERSION FACTORS FOR LATENT HEAT

	cal/g	joules/g	$\frac{\text{watt sec}}{\text{g}}$	Btu/lb
1 cal/g =	1	4.184	4.184	1.798823
1 joules/g =	0.239006	1	1	0.429929
1 $\frac{\text{watt sec}}{\text{g}}$ =	0.239006	1	1	0.429929
1 Btu/lb =	0.555919	2.32597	2.32597	1

CONVERSION FACTORS FOR THERMAL CONDUCTIVITY

	$\frac{\text{Watts}}{\text{cm °K}}$	$\frac{\text{Watts}}{\text{in °R}}$	$\frac{\text{cal}}{\text{sec cm °K}}$	$\frac{\text{Btu in}}{\text{hr ft}^2\text{ °R}}$	$\frac{\text{Btu}}{\text{hr ft °R}}$	$\frac{\text{Btu}}{\text{sec in °R}}$	$\frac{\text{Btu}}{\text{hr in °R}}$	$\frac{\text{k cal}}{\text{hr m °K}}$
1 $\frac{\text{Watt}}{\text{cm °K}}$ =	1	1.4111	0.2390	693.4	57.78	1.337×10^{-3}	4.81499	86.04
1 $\frac{\text{Watt}}{\text{in °R}}$ =	0.7087	1	0.16937	491.4	40.946	9.478×10^{-4}	3.412	60.97
1 $\frac{\text{cal}}{\text{sec cm °K}}$ =	4.184	5.904	1	2901	241.8	5.596	20.15	360
1 $\frac{\text{Btu in}}{\text{hr ft}^2\text{ °R}}$ =	1.4423×10^{-3}	2.035×10^{-3}	3.447×10^{-4}	1	0.08333	1.9290×10^{-6}	6.944×10^{-3}	0.12409
1 $\frac{\text{Btu}}{\text{hr ft °R}}$ =	0.01731	0.02442	4.136×10^{-3}	12	1	2.3148×10^{-5}	0.08333	1.4891
1 $\frac{\text{Btu}}{\text{sec in °R}}$ =	747.7	1.0550	178.70	518,400	43,200	1	3600	6.433×10^{4}
1 $\frac{\text{Btu}}{\text{hr in °R}}$ =	0.2077	0.2931	0.04964	144	12	2.778×10^{-4}	1	17.87
1 $\frac{\text{k cal}}{\text{hr m °K}}$ =	0.011622	0.016400	2.778×10^{-3}	8.058	0.6715	1.55447×10^{-5}	0.05596	1

CONVERSION FACTORS FOR DIFFUSIVITY

	ft^2/hr	ft^2/sec	in^2/sec	cm^2/hr	cm^2/sec
1 ft^2/hr =	1	2.778×10^{-4}	0.04	929.0	0.2581
1 ft^2/sec =	3600	1	144	3.3445×10^{6}	929.0
1 in^2/sec =	25	6.944×10^{-3}	1	2.323×10^{4}	6.452
1 cm^2/hr =	1.0764×10^{-3}	2.990×10^{-7}	4.306×10^{-5}	1	2.778×10^{-4}
1 cm^2/sec =	3.875	1.0764×10^{-3}	0.15500	3600	1

CONVERSION FACTORS FOR VAPOR PRESSURE

	dyne/cm²	standard atmosphere	kg/cm²	mm Hg	in Hg	lb/in²	lb/ft²
1 dyne/cm² =	1	9.869×10^{-7}	1.0197×10^{-6}	7.501×10^{-4}	2.953×10^{-5}	1.4504×10^{-5}	2.089×10^{-3}
1 standard atmosphere =	1.0133×10^{6}	1	1.0332	760	29.92	14.696	2116
1 kg/cm² =	9.807×10^{5}	0.9678	1	735.6	28.96	14.223	2048
1 mm Hg =	1333.2	1.3158×10^{-3}	1.3595×10^{-3}	1	0.03937	0.019337	2.7845
1 in Hg =	3.386×10^{4}	0.03342	0.03453	25.40	1	0.4912	70.73
1 lb/in² =	6.8947×10^{4}	0.068046	0.07031	51.71	2.036	1	144
1 lb/ft² =	478.8	4.725×10^{-4}	4.882×10^{-4}	0.3591	0.014139	6.944×10^{-3}	1

PROPERTIES OF PLAIN CARBON STEELS

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	491 lb_m/ft^3	7.86 g/cm^3
Melting Point	2520-3180°R *	1400-1765°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .	$3100_{2770°R}$ Btu/lb_m **	$1720_{1540°K}$ cal/g **

* At 2.0 and 0.10% C respectively; M.P. decreases with increasing C content. Metals Handbook (Ref. 48-11)
** Austenite; see Ref. Info.

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3
○	490.6	7.858
▽	490	7.85
⬡	490	7.85
⌂	489	7.84

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

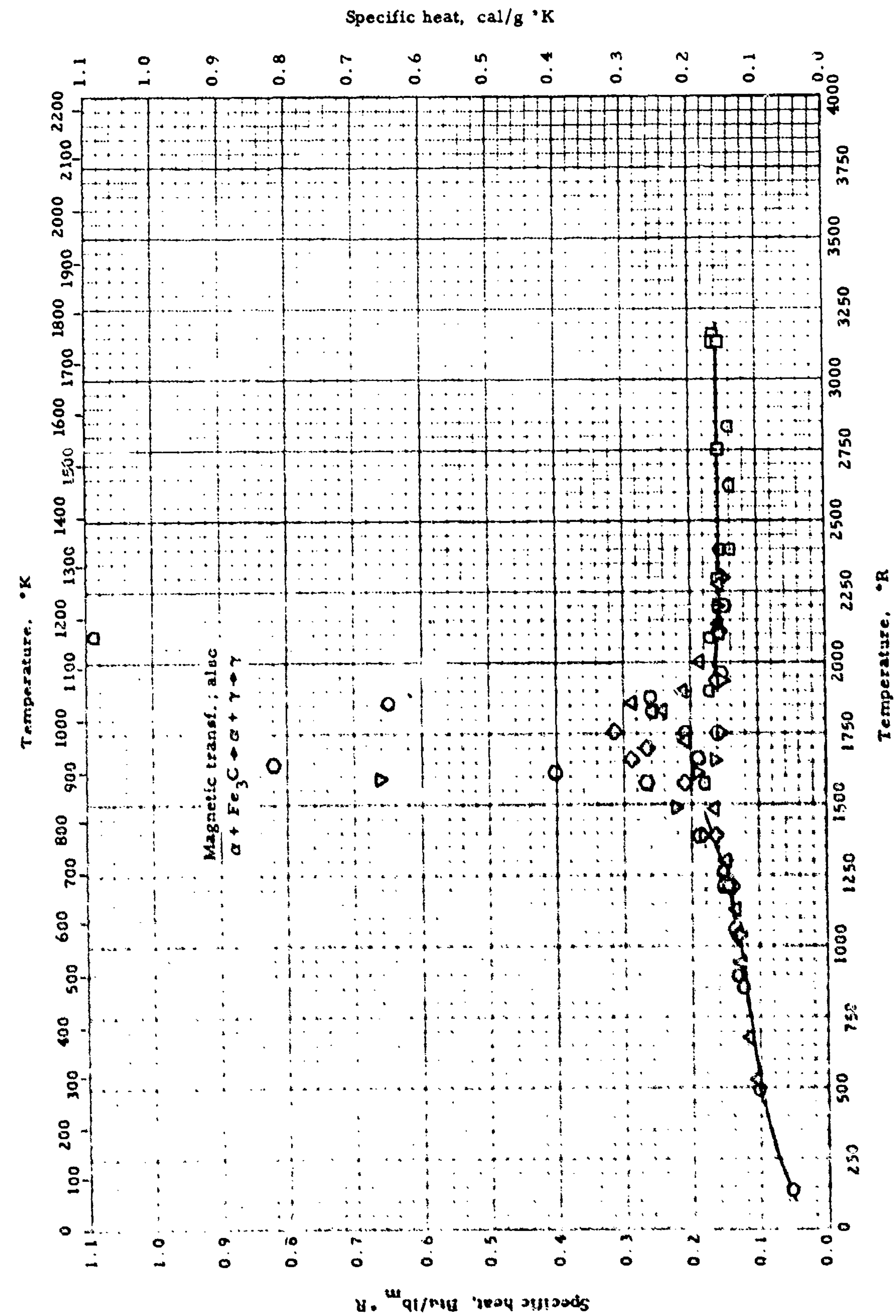
Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation:

	Btu/lb_m	cal/g	% C
□	$3100_{2770°R}$	$1720_{1540°K}$	0.59
△	$2950_{2770°R}$	$1640_{1540°K}$	0.96
◇	$1470_{2470°R} \pm 10$	$816_{1370°K} \pm 5$	1.31

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5	528	SAE 1010 Steel; nominal: 0.08 - 0.13% C; 0.30 - 0.60% Mn	ρ: weight and volume by water displacement	
□	Vintaikin, E.Z.	57-39	2540-3010	Austenite; 0.59% C	Δh_s: from vapor pressure by Knudsen method	Vapor pressure measured from 2540 - 3010°R
△	Ibid.	57-39	2540-3010	Austenite; 0.96% C	Δh_s: same as above	Same as above
◇	Kornev, Yu.V.	53-53	2330-2630	Austenite; 1.31% C	Δh_s: from vapor pressure by Knudsen method with radio-active counting	Vapor pressure measured from 2330 to 2630°R
▽	Lucks, C.F. and Thompson, H.B. et al.	51-65	528	SAE 1010 Steel; nominal: 0.42% Mn; 0.10% C; 0.028% S; 0.008% P	ρ: weight in air and in water	Hot rolled
○	Ibid.	51-65	Room	SAE 1019 Steel; nominal: 0.42% Mn; 0.10% C; 0.028% Si; 0.008% P	ρ: not given	Hot rolled
○	Pallister, P.R.	57-6	Room	Mild steel: 0.61% Mn; 0.20% Si; 0.13% C; 0.12% Ni; 0.01% Cr	ρ: not given	

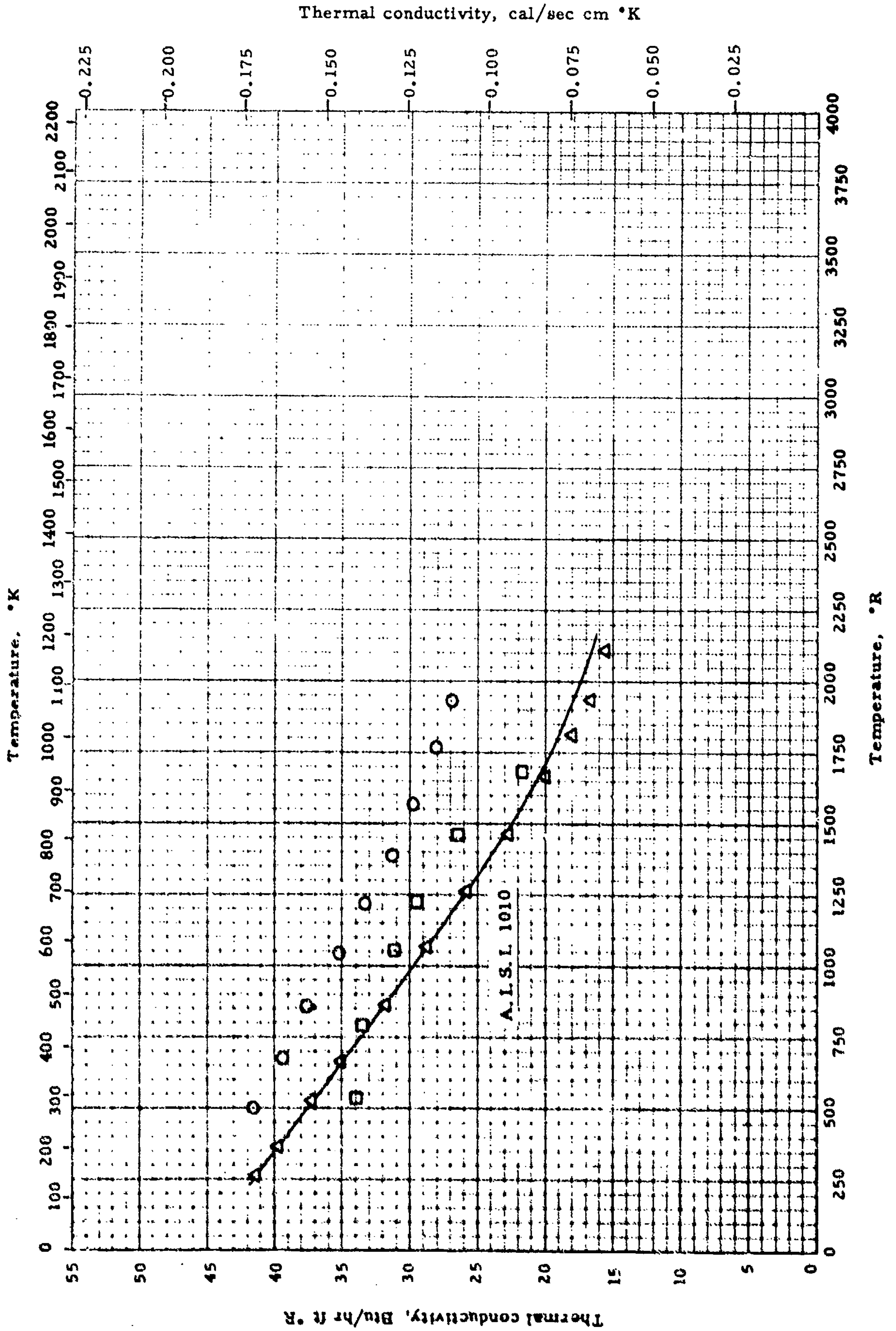


SPECIFIC HEAT -- PLAIN CARBON STEEL
(0.20-0.60% C)

SPECIFIC HEAT -- PLAIN CARBON STEEL
(0.20 - 0.60% C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F., Matolich, J. and Van Valzor, J.A.	54-27 also 58-5	132-2022	Mild steel, SAE 1010	Drop method; ice calorimeter	
□	Pattison, J.R. and Lonsdale, T.H.	56-27	492-3209	0.44% Mn; 0.14% Cu; 0.12% C; 0.08% Ni; 0.035% P; 0.03% Cr; 0.022% S, <0.02% Al, <0.01% Si; 0.003% N_2	Drop method; water calorimeter	
△	Pallister, P.R.	57-6	492-2292	Mild steel, 0.61% Mn; 0.20% Si; 0.13% C; 0.12% Ni; 0.01% Cr. $\rho = 489\ lb_m/ft^3$	Slope of initial temp. rise curve in resistance heated sample	
◇	Bartenev, G.M.	40-8	1032-2292	0.53% Mn; 0.15% C; 0.045% P; 0.038% S; 0.004% Si	Comparative; rate of temp. drop in sample compared with standard under same cooling condition	Tungsten used as standard: Cooling rate (°C/sec) — °C 13.3-14.5 — 900 7.0-8.0 — 700 3.1-3.8 — 500 1.5-1.6 — 300 Transf. temp. depressed by high cooling rates
▽	Ibid.	40-8	1032-2202	1.04% Mn; 0.33% C; 0.110% P; 0.100% Si; 0.050% S	Same as above	Same as above
○	Ibid.	40-8	1032-2202	0.72% Mn; 0.50% C; 0.3% Si; 0.035% P; 0.030% S	Same as above	Same as above
⌂	Oelsen, W.	57-131	890-2830	Very low carbon steel	Enthalpy meas. with flowing air calorimeter	Author reports enthalpy. Computed c_p from $\frac{\Delta H}{\Delta T}$

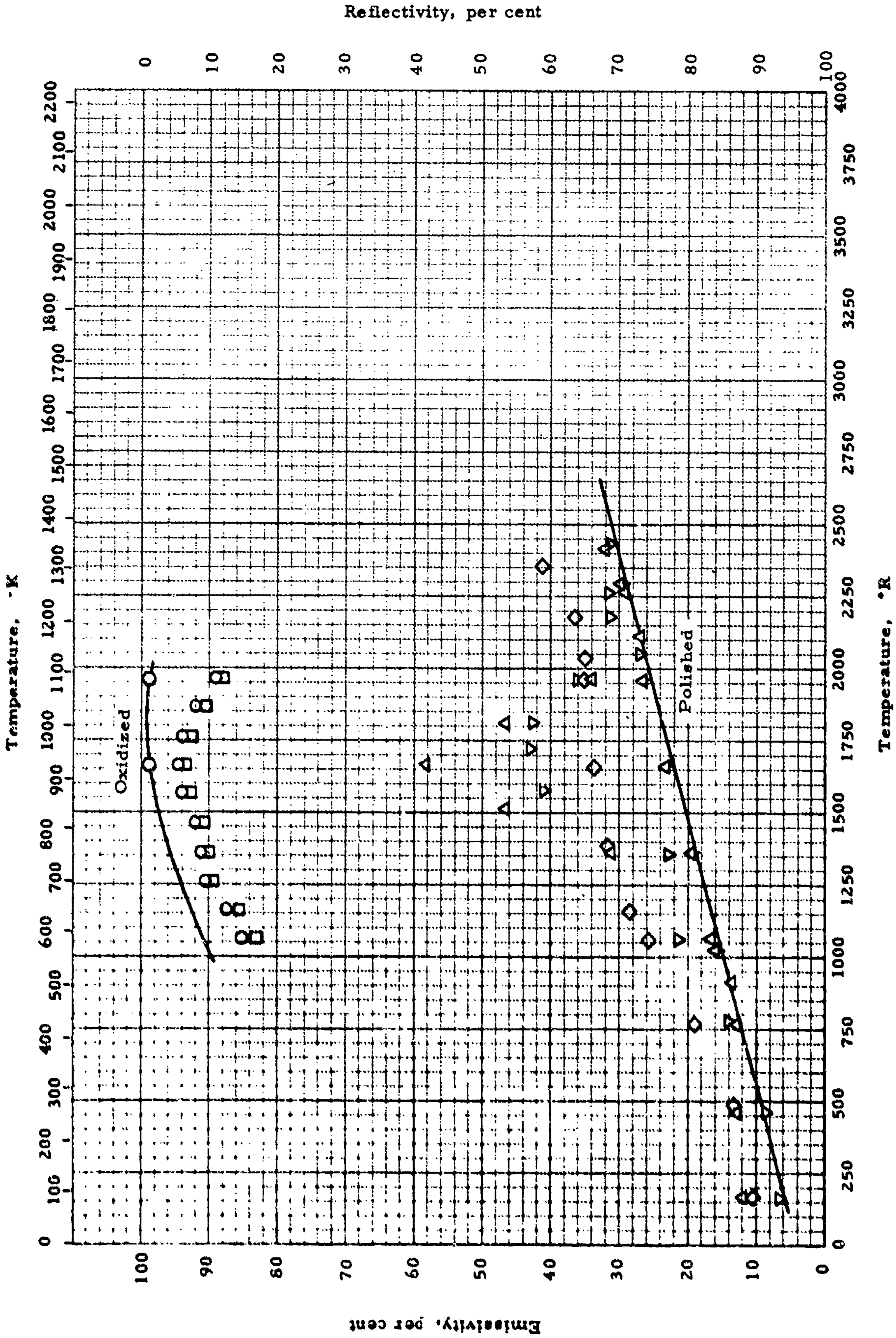


THERMAL CONDUCTIVITY -- PLAIN CARBON STEEL

THERMAL CONDUCTIVITY -- PLAIN CARBON STEEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sawyer, R. B.	55-5 also 52-75 55-115	492-1932	AISI 1010	Temp. distribution in bar heated at one end	Controlled atmos. furnace
□	Raezer, S. D.	54-14	535-1961	Basic; AISI 1010: 0.42% Mn; 0.10% Si; 0.08% C; 0.03% S; 0.015% P	Temp. distribution in bar heated at one end	Annealed at 600°C in N_2 atmos. test run under 10 psig N_2
△	Lucks, C. F. and Deem, H. W.	58-5 also 51-65	260-2110	AISI 1010	Comparative; rods (Armco Iron standard)	Hot rolled

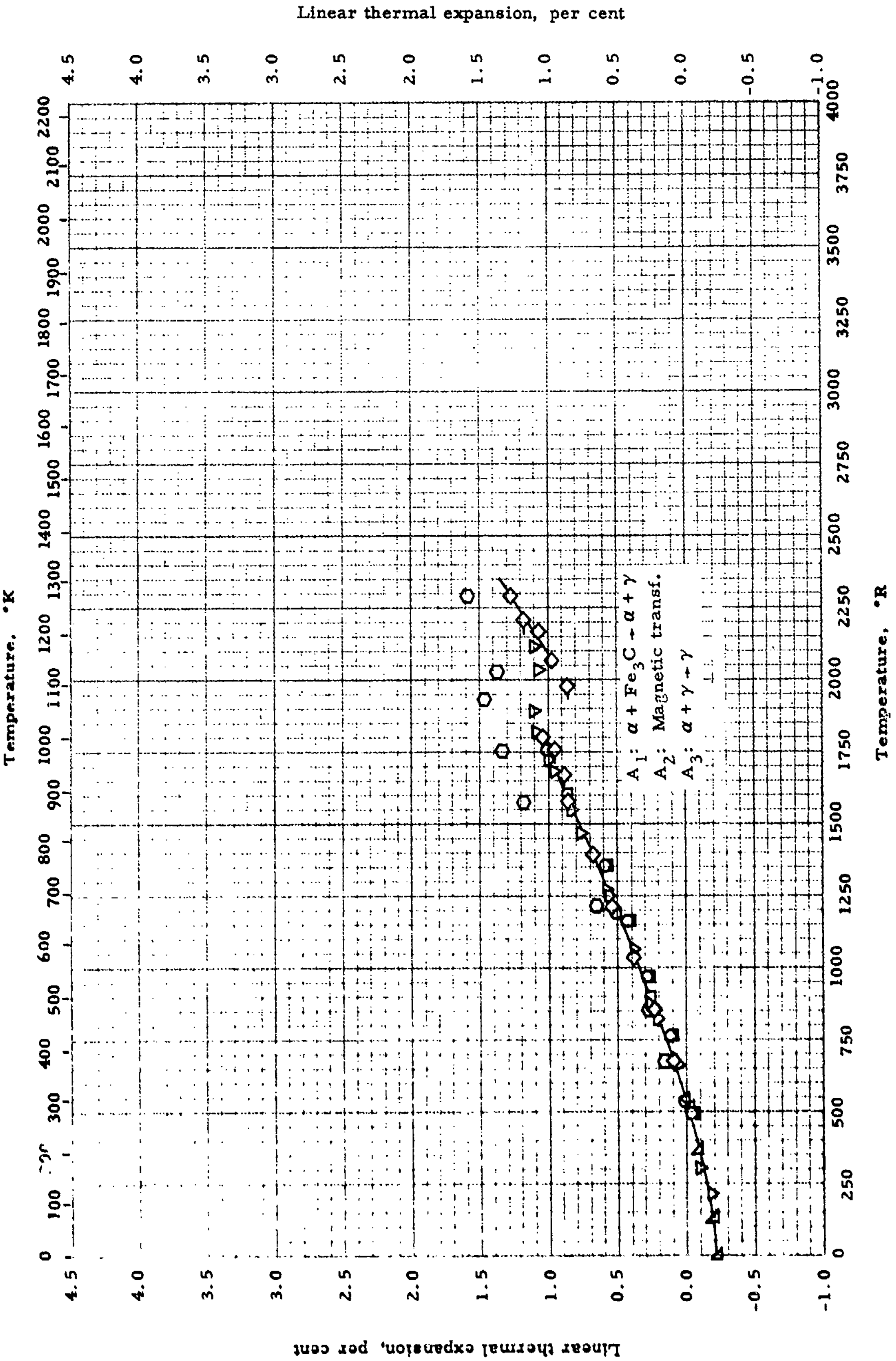


EMISSIVITY -- PLAIN CARBON STEEL

EMISSIVITY -- PLAIN CARBON STEEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wade, W. R.	58-20	1060-1960	Mild Steel AISI C1020	Total normal emissivity: radiant heat meas. with thermopile, calibrated by black body	Polished, oxidized 30+ min. at 1500 °C
□	Ibid.	58-20	1060-1960	Same as above	Total hemispherical emissivity: same as above	Same as above
△	Wilkes, G. B.	54-122	160-2410	Mild Steel	Total hemispherical emissivity: comparative; radiant heat flow compared with that of a black body using thermopile in vac. of 10μ Hg. Temp. by Cu-Const. and Chromel-Alumel thermocouples	As received, wiped with toluene until clean, then with methyl alcohol △ - first heating run △̣ - cooling run
◇	Ibid.	54-122	160-2360	Same as above	Same as above	Scrubbed with Bon Ami; washed with water and dried; wiped with toluene and then with alcohol
▽	Ibid.	54-122	160-2430	Same as above	Same as above	Polished; buffed until mirror-like and free of scratches, washed with soap and water
○	Haie, J. C. and Douglas, E. A.	55-126	1660-1960	Mild Steel	Total normal emissivity: not described here, refers to others	Oxidized at 1800 °F for 15 min.

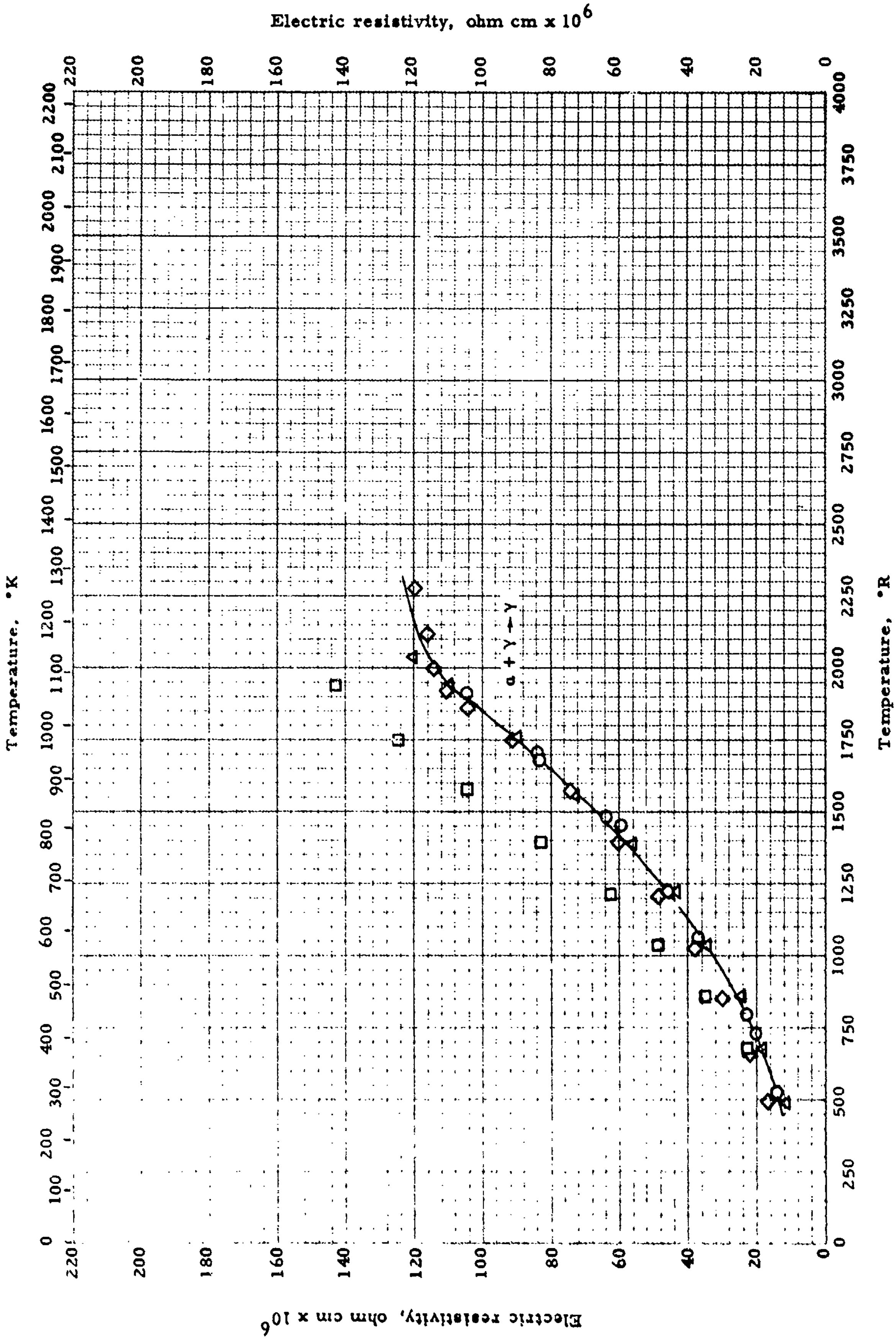


LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.02% - 0.20% C)

LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.02% - 0.20% C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Andrew, J.H., Lee, H. et al.	50-8	492-1810	0.05% Mn; 0.04% C; 0.015% S; 0.01% Si; 0.005% P	Dilatometer	Normalized so that initial structure is ferrite and lamellar pearlite
□	Ibid.	50-8	492-1812	0.63% Mn; 0.16% C; 0.07% Si; 0.012% P; 0.010% S	Same as above	Same as above
△	Rosenfield, A.R. and Averbach B.E.	55-15	515-542	SAE 1020 steel. 0.89% Mn; 0.20% C; 0.17% Si; 0.064% S; 0.015% P	Strain gages glued to sample	Coeff. of exp. given as 11.1×10^{-6}/°C for 13-28°C
◇	Esser, H. and Eusterbrock, H.	41-17	528-2292	0.13% C; <0.03% O_2; <0.02% Mn; <0.004% Si; <0.0024% S	Comparative dilatometer; (Au standard)	Annealed 1 hr. at 700°C in vacuum, cooled slowly. ◇ : heating; -◇: cooling
▽	Lucks, C.F. and Deem, H.W.	58-5 also 51-65	210-2110	SAE 1010 steel from U.S. Steel. ρ = 490 lb_m/ft^3	Quartz tube dilatometer	Hot rolled. Tested in vacuum
○	Abe, F., Kimura, K. and Saito, T.	53-96	528-2292	"Low carbon steel"	Not given here; refers to others	
◻	Cornelius, H.	43-17	528-1752	0.46% Mn; 0.17% Si; 0.07% C; 0.014% S; 0.012% P	Comparative dilatometer	Tested in vacuum at 1.5°C/min. rise
▽	Ibid.	43-17	528-1752	1.51% Mn; 0.34% Si; 0.08% C; 0.013% S; 0.012% P	Same as above	Same as above
◺	Laquer, H.L.	52-39	0-540	SAE 1020 steel	Interferometer	Integrated values of unpublished thermal expansion coefficients by Altman, Rubin, and Johnston (1949-50)

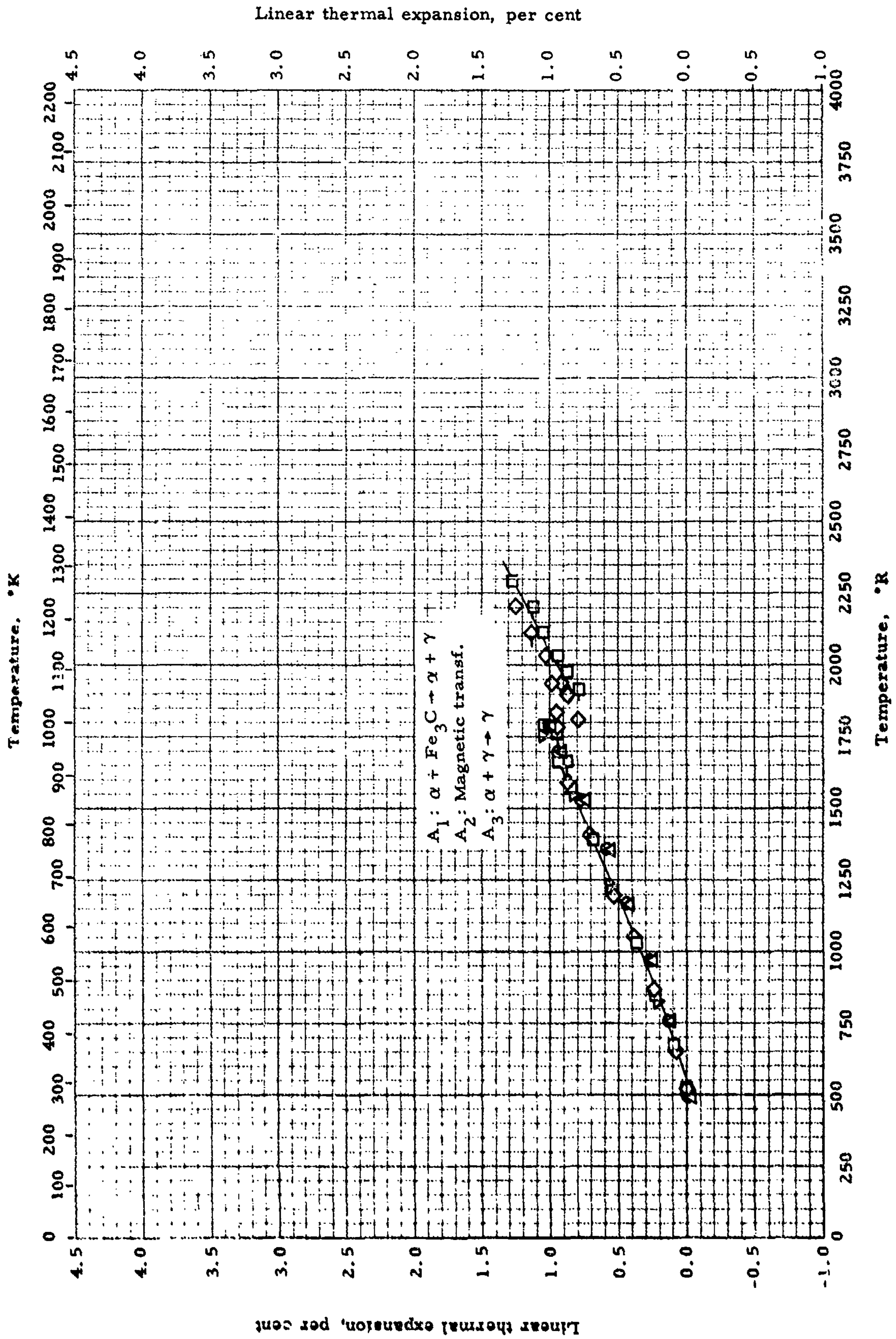


ELECTRIC RESISTIVITY -- PLAIN CARBON STEEL

ELECTRIC RESISTIVITY -- PLAIN CARBON STEEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raezer, S. D.	54-14	535-1905	0.42% Mn; 0.10% Si; 0.08% C; 0.03% S; 0.015% P	Potential drop	Annealed at 600°C in N_2 atmos. Test run in N_2 atmos. at 10 psi
△	Sawyer, R. B.	55-5 55-115	492-2040	SAE 1010 steel	Not given, refers to others	
□	Hogan, C. L., and Sawyer, R. B.	52-75	492-2112	SAE 1010 steel	Potential drop; sample temp. by Chromel-Alumel thermocouple	
◇	Pallister, P. R.	57-6	492-2292	0.61% Mn; 0.20% Si; 0.13% C; 0.12% Ni; 0.01% Cr. $\rho = 489\ lb_m/ft^3$	Potential drop	

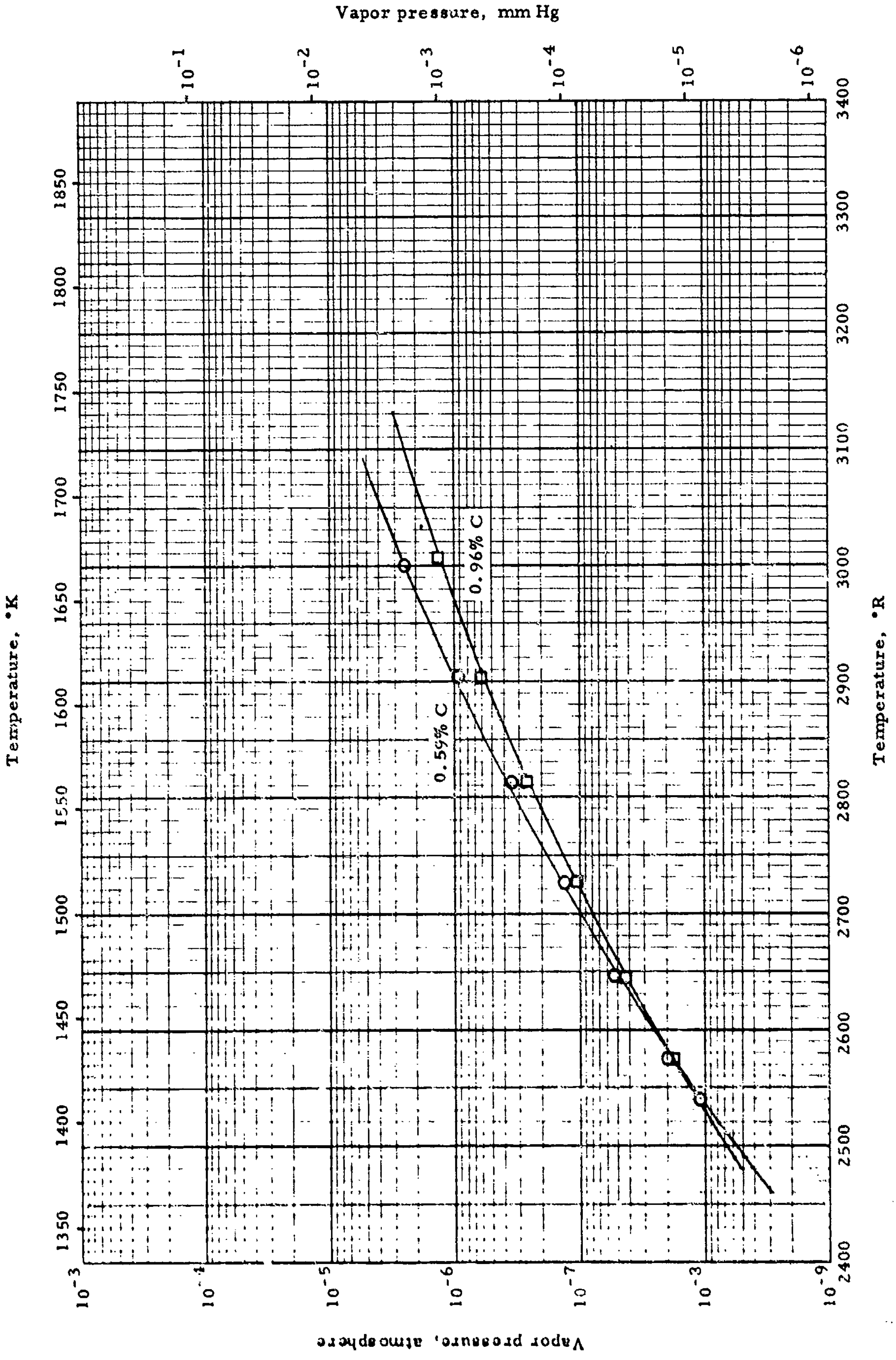


LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.2% < C < 0.60%)

LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.2% < C < 0.60%)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Andrew, J.H., Lee, H. et al.	50-8	492-1796	0.60% Mn; 0.27% C; 0.21% Si	Dilatometer	Normalized so that initial structure is ferrite and lamellar pearlite
△	Ibid.	50-8	490-1800	0.58% C; 0.033% Mn; 0.10% Si	Same as above	Same as above
□	Esser, H. and Eusterbrock, H.	41-17	528-2292	0.26% C; <0.03% O_2; <0.02% Mn; <0.004% Si; <0.0024% S	Comparative dilatometer (Au standard)	Annealed 1 hr. at 700°C in vacuum □ - heating; -□ - cooling
◇	Ibid.	41-17	528-2292	0.47% C; others, same as above	Same as above	◇- heating; -◇- cooling
▽	Cornelius, H.	43-17	528-1752	0.62% Mn; 0.34% Si; 0.25% C; 0.026% S; 0.020% P	Comparative dilatometer	Tested at 1.5°C/min. rise
○	Ibid.	43-17	528-1752	1.85% Mn; 0.38% C; 0.33% Si; 0.027% P; 0.025% S	Same as above	Same as above

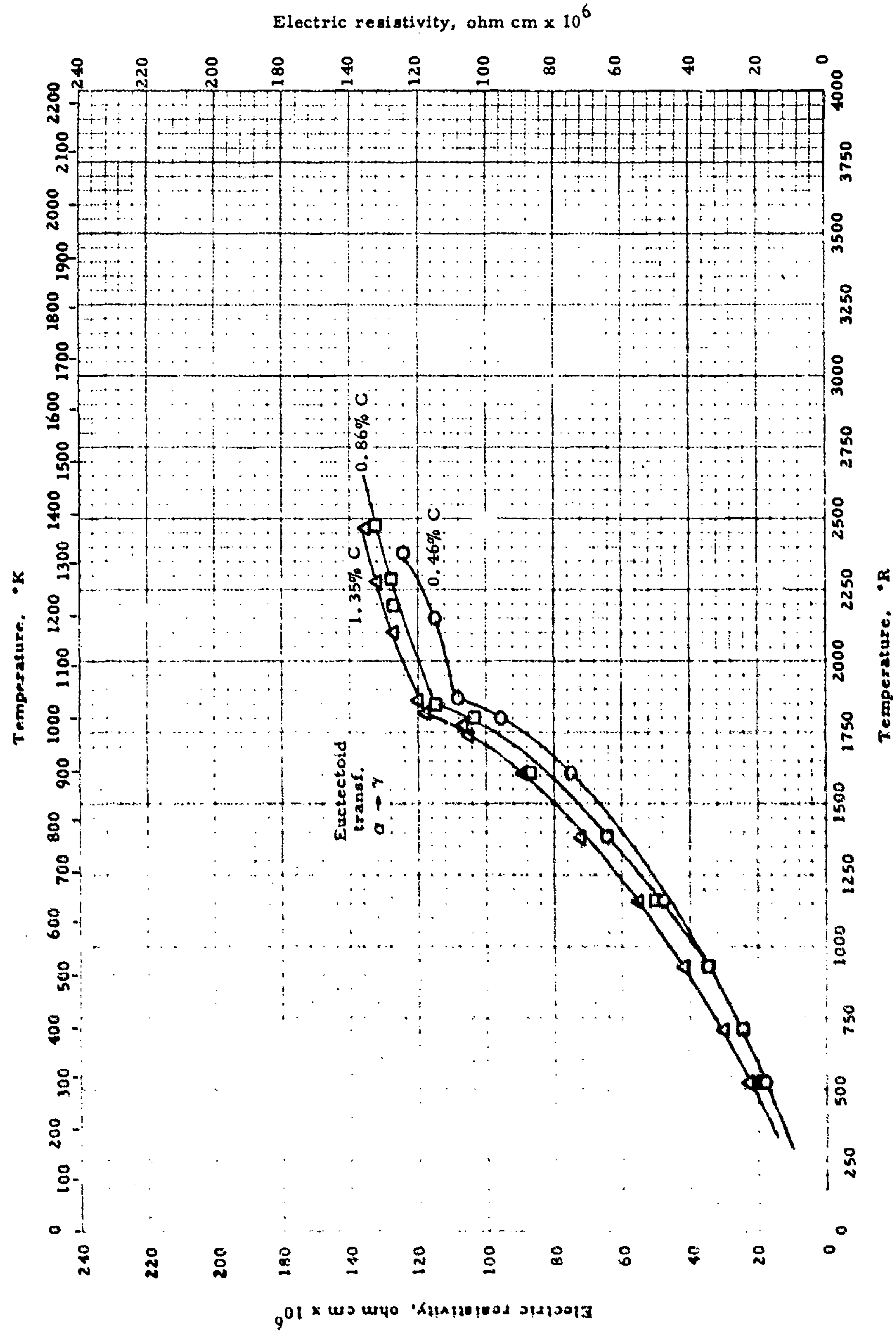


VAPOR PRESSURE -- PLAIN CARBON STEEL

VAPOR PRESSURE -- PLAIN CARBON STEEL

REFERENCE INFORMATION

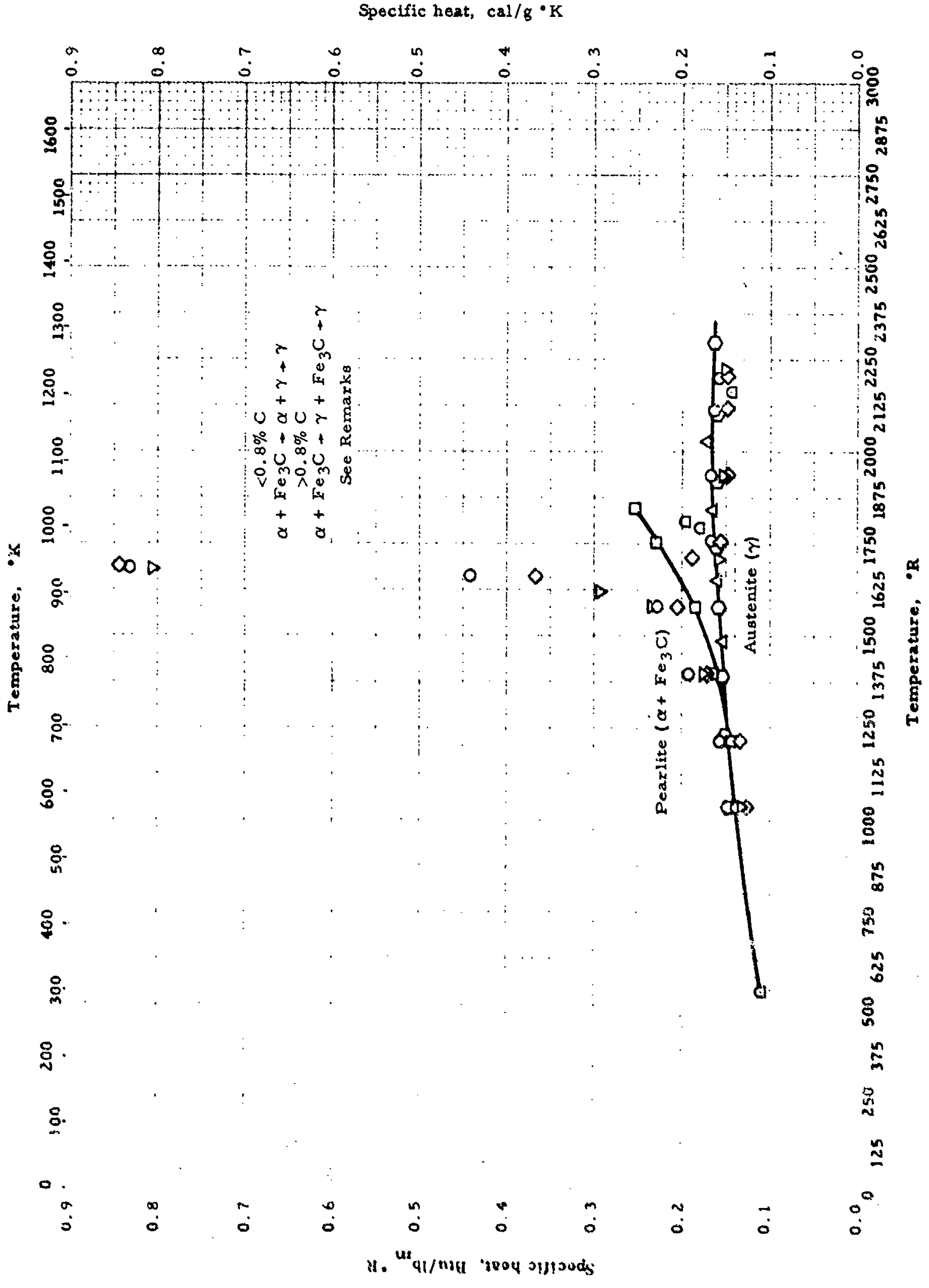
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Vintaikin, E. Z.	57-39	2538-3006	Austenite; 0.59% C; prepared by fusion of "pure" Fe with cast Fe in He atmos.	Knudsen effusion cell; radioactive Fe^{59} tracer	
□	Ibid	57-39	2538-3006	Austenite; 0.96% C; prepared same as above.	Same as above	



ELECTRIC RESISTIVITY -- CARBON STEEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Blanter, M. E.	47-13	528-2382	0.46% C (in the form of Fe_3C)	Potential drop	Exposed to high annealing to obtain granulated pearlite prior to testing. Tested at 20°C/min rise above 500°C. Auth. est. accuracy ± 2%
□	Ibid.	47-13	528-2472	0.86% C (in the form of Fe_3C)	Same as above	Same as above
△	Ibid.	47-13	528-2472	1.35% C (in the form of Fe_3C)	Same as above	Same as above



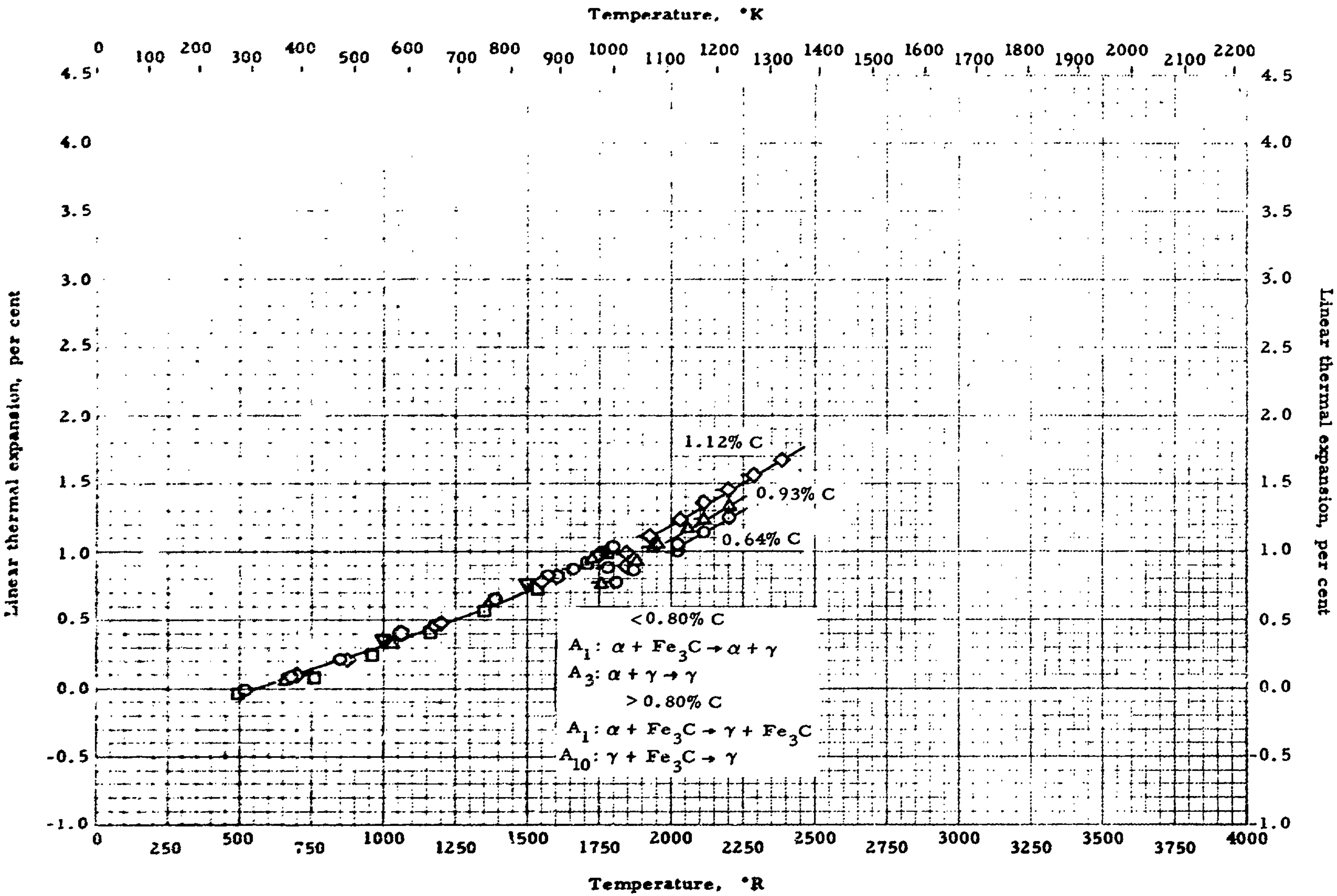
SPECIFIC HEAT -- PLAIN CARBON STEEL
(0.60-1.50% C)

59-909

SPECIFIC HEAT -- PLAIN CARBON STEEL (0.60-1.50% C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bartenev, G.M.	40-8	1032-2202	0.67% C; 0.31% Mn; 0.078% Si; 0.025% S; 0.012% P	Comparative; rate of temp. drop in sample compared with standard under same cooling conditions	Tungsten used as standard: Cooling rate (°C/sec) — °C 13.3-14.5 — 900 7.0-8.0 — 700 3.1-3.8 — 500 1.5-1.6 — 300 Transf. temp. depressed by high cooling rates
◇	Ibid.	40-8	1032-2202	0.97% C; 0.18% Mn; 0.120% Si; 0.028% S; 0.018% P	Same as above	Same as above
▽	Ibid.	40-8	1032-2202	1.21% C; 0.25% Mn; 0.18% Si; 0.038% P; 0.021% S	Same as above	Same as above
○	Ibid.	40-8	1032-2292	0.81% C; 0.39% Si; 0.32% Mn; 0.008% ea. P, S	Same as above	Same as above
□	Hagel, W.C., Pound, G.M., and Mehl, R.F.	54-9	1212-1842	Eutectoid Steel, Pearlite; 0.27-1.85% Mn; 0.79-0.80% C; 0.22% Si; 0.011-0.02% P; 0.011-0.016% S	Comparative: rate of temp. rise in sample compared with standard under same heating conditions	No measurable change in c_p for given composition range
△	Ibid.	54-9	1482-2022	Eutectoid Steel, Austenite; same analysis as above	Same as above	Same as above
○	Oelsen, W., Rieskamp, K.H. and Oelsen, O.	55-125	537-2166	0.96% C; 0.23% Mn; 0.1% Ni; 0.02% Mo; 0.01% P	Sample cooled slowly in water calorimeter	Auth. report enthalpy. Least square square eqn. fitted by ARF

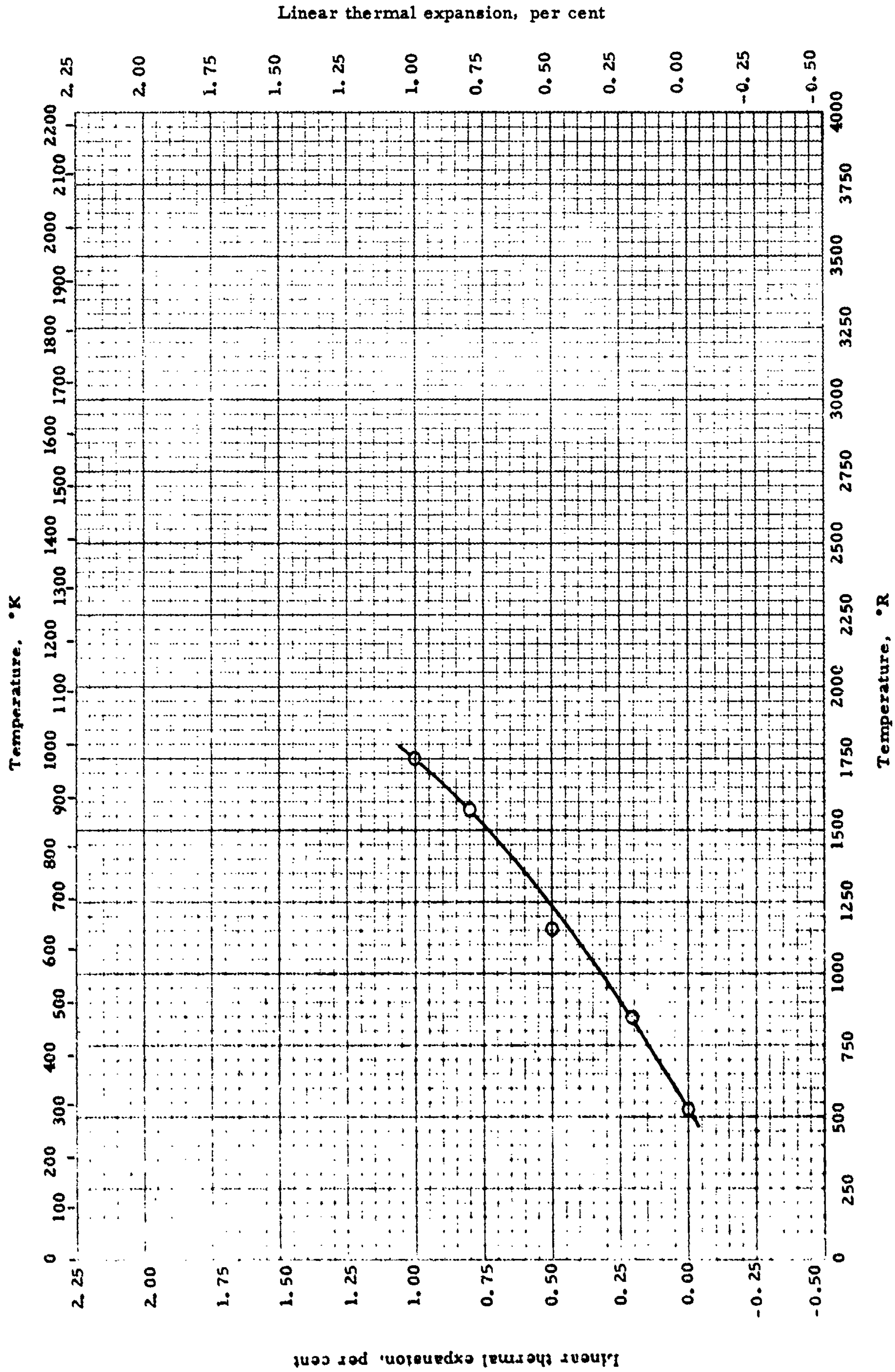


LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.60 - 1.20% C)

LINEAR THERMAL EXPANSION -- PLAIN CARBON STEEL
(0.60 - 1.20% C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
□	Andrew, J.H., Lee, P.L., et al.	50-8	490-1810	0.81% C; 0.34% Mn; 0.10% Si	Dilatometer	Normalized to initial structure of ferrite and lamellar pearlite
○	Esser, H., and Eusterbrock, H.	41-17	528-2202	0.64% C; <0.03% O_2; <0.02% Mn; <0.004% Si; < 0.0024% S	Comparative dilatometer (Au standard)	Annealed 1 hr. at 700°C in vacuum, cooled slowly ○: heating; -○: cooling
△	Ibid.	41-17	528-2202	0.93% C; others as above	Same as above	Same as above △: heating; -△: cooling
◇	Ibid.	41-17	528-2202	1.12% C; others as above	Same as above	Same as above ◇: heating; -◇: cooling
▽	Cornelius, H.	43-17	528-2112	2 samples: a) 0.62% C; 0.54% Mn; 0.20% Si; 0.021% S; 0.015% P b) 0.77% C; 0.13% Si; 0.13% Mn; 0.015% S; 0.006% P	Quartz tube dilatometer; Leitz-Bollenrath	Points shown are mean values with 0.75% max. deviation
○	Ibid.	43-17	528-2112	0.65% C; 0.24% Mn; 0.23% Si	Same as above	



LINEAR THERMAL EXPANSION -- CARBON STEEL
(1.20% < C ≤ 1.50%)

LINEAR THERMAL EXPANSION -- CARBON STEEL
($1.20\% < C \leq 1.50\%$)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H.	43-17	528-1752	Steel 1.40% C; 0 - 18% Mn; 0.12% Si; 0.01% P; 0.01% S	Quartz tube dilatometer, Leitz-Bollenrath	

PROPERTIES OF GRAY CAST IRON

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	500 lb_m/ft^3	8 g/cm^3
Melting Point	2560°R *	1420°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3	Nominal % C
	O	498	7.97	3.25
	□	451 ± 6	7.22 ± 0.1	2.96-3.74

Melting Point:	°R	°K

Heat of Fusion:	Btu/lb_m	cal/g

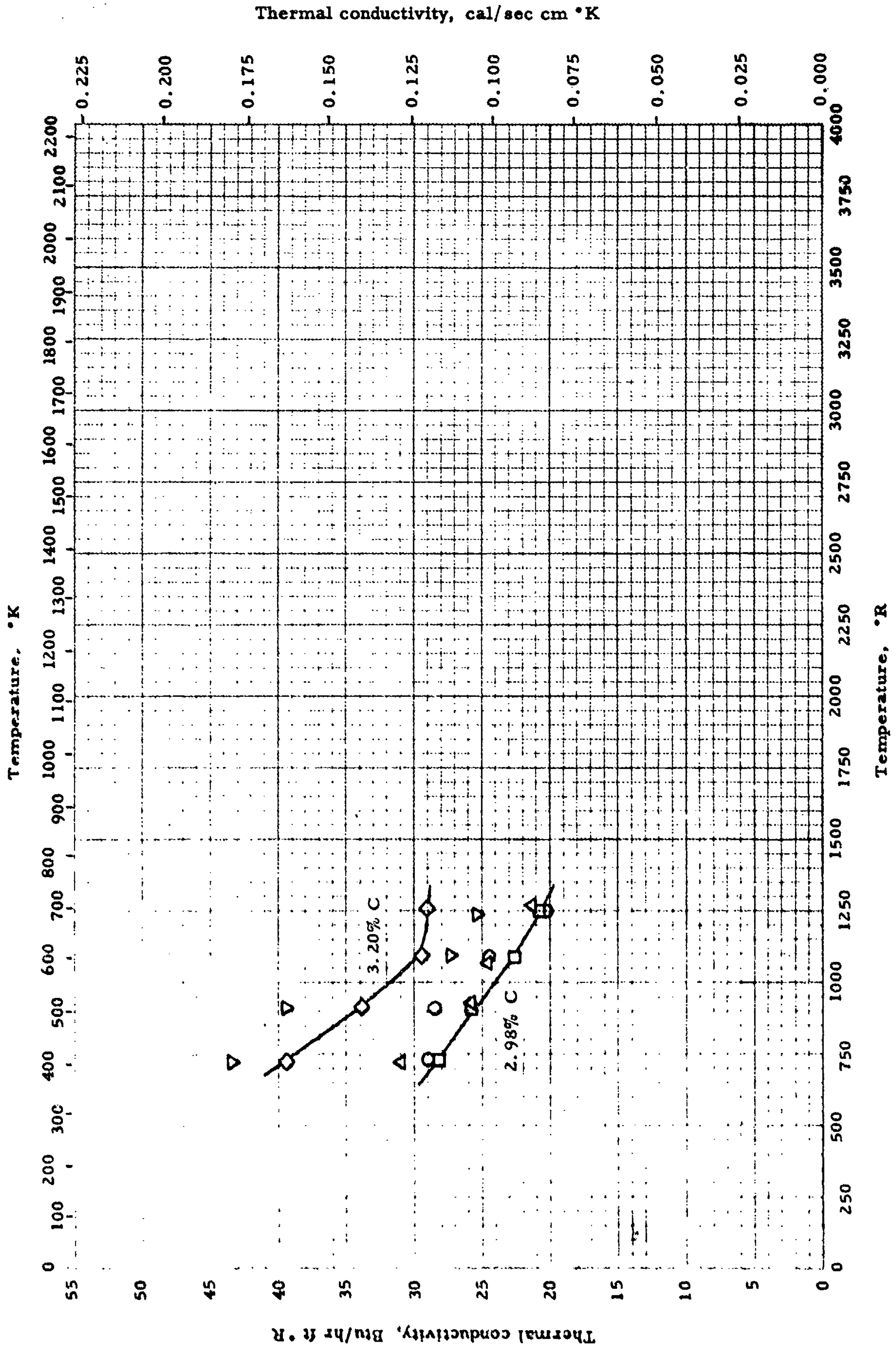
Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF GRAY CAST IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Massengale, C.B. et al.	52-79	Room	Nominal: 3.25% C; 1.75% Si; 0.6% Mn; 0.1% P; 0.08% S	ρ: weight and volume from measured dimensions	Average of 6 samples
□	Ferry, M.	57-89	Room	Gray Cast Iron not containing lamellar graphite, series: 2.96-3.74% C; 1.35-2.85% Si; 0.37-1.07% Mn; 0.02-0.13% S; 0.18-1.01% P	ρ: weight in air and CCl_4 to 10^{-4} g	Auth. correlates ρ with C by $\rho = 6.4 + 0.2\ (C + 0.33\ Si + 0.33\ P)\ g/cm^3$; C, Si and P in per cent

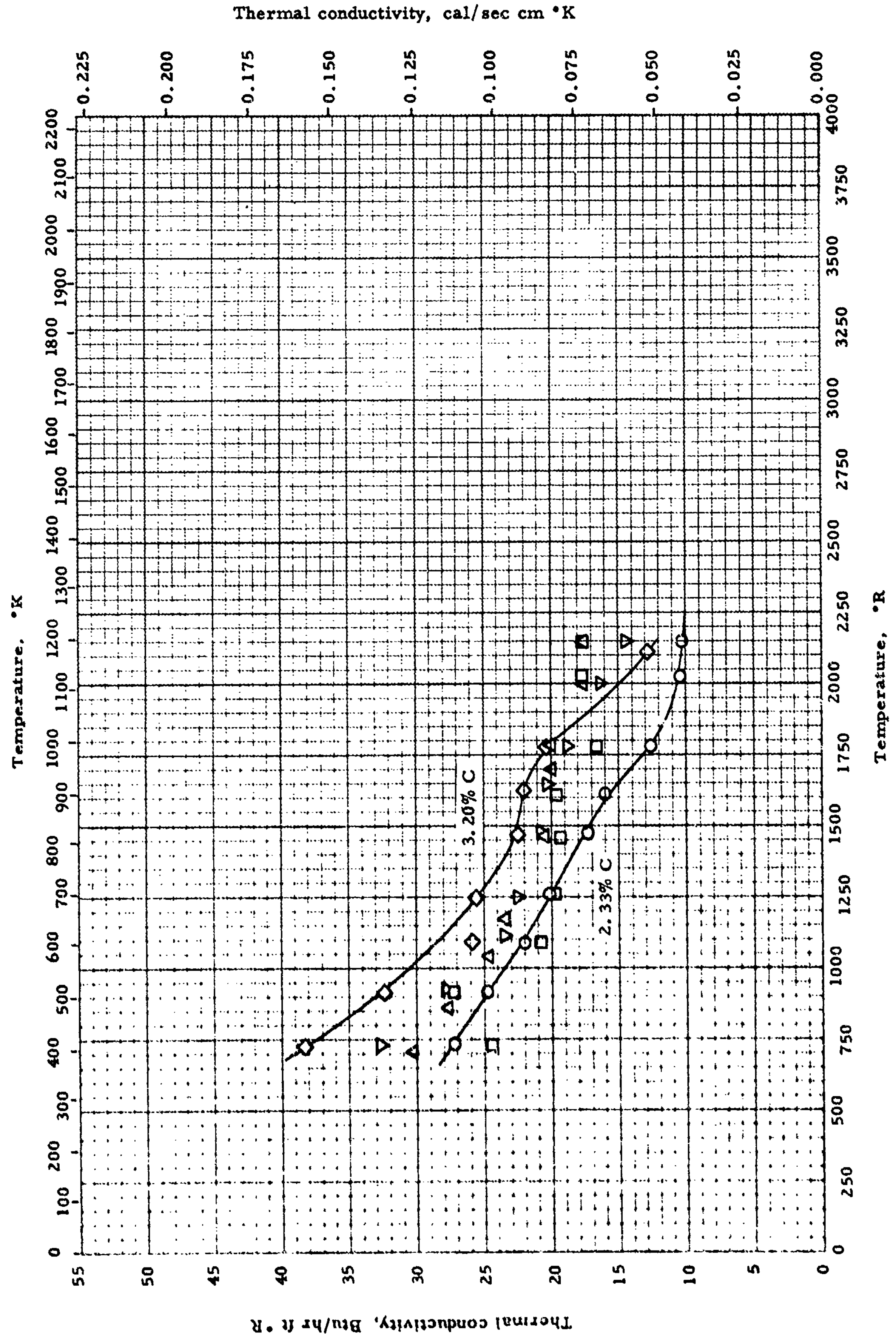


THERMAL CONDUCTIVITY -- GRAY CAST IRON, FERRITIC

THERMAL CONDUCTIVITY -- GRAY CAST IRON, FERRITIC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovskii, B.B., and Gel'd, P.V.	56-35	735-2148	2.33% C; 1.20% Si; 1.20% C_{comb}; 0.36% Mn; 0.143% P; 0.10% Ni; 0.69% S; 0.06% Cr	Radial heat flow in cylinder	Auth. est. accuracy ± 5%
□	Ibid.	56-35	735-2148	2.98% C; 1.94% Si; 1.5% Mn; 0.75% C_{comb}; 0.490% Cr; 0.456% P; 0.130% Ni; 0.077% S	Same as above	Same as above
△	Ibid.	56-35	735-2148	3.05% C; 1.82% Si; 0.91% Mn; 0.85% C_{comb}; 0.65% W; 0.509% P; 0.42% Cr; 0.090% Ni; 0.083% S	Same as above	Same as above
◇	Ibid.	56-35	735-2148	3.20% C; 2.75% Si; 0.88% Mn; 0.61% C_{comb}; 0.143% P; 0.116% S; 0.10% Ni; 0.09% Cr	Same as above	Same as above
▽	Ibid.	56-35	735-2148	3.82% C; 2.02% Si; 0.95% Mn; 0.65% C_{comb}; 0.484% P; 0.9% Cr; 0.15% Ni; 0.090% S	Same as above	Same as above

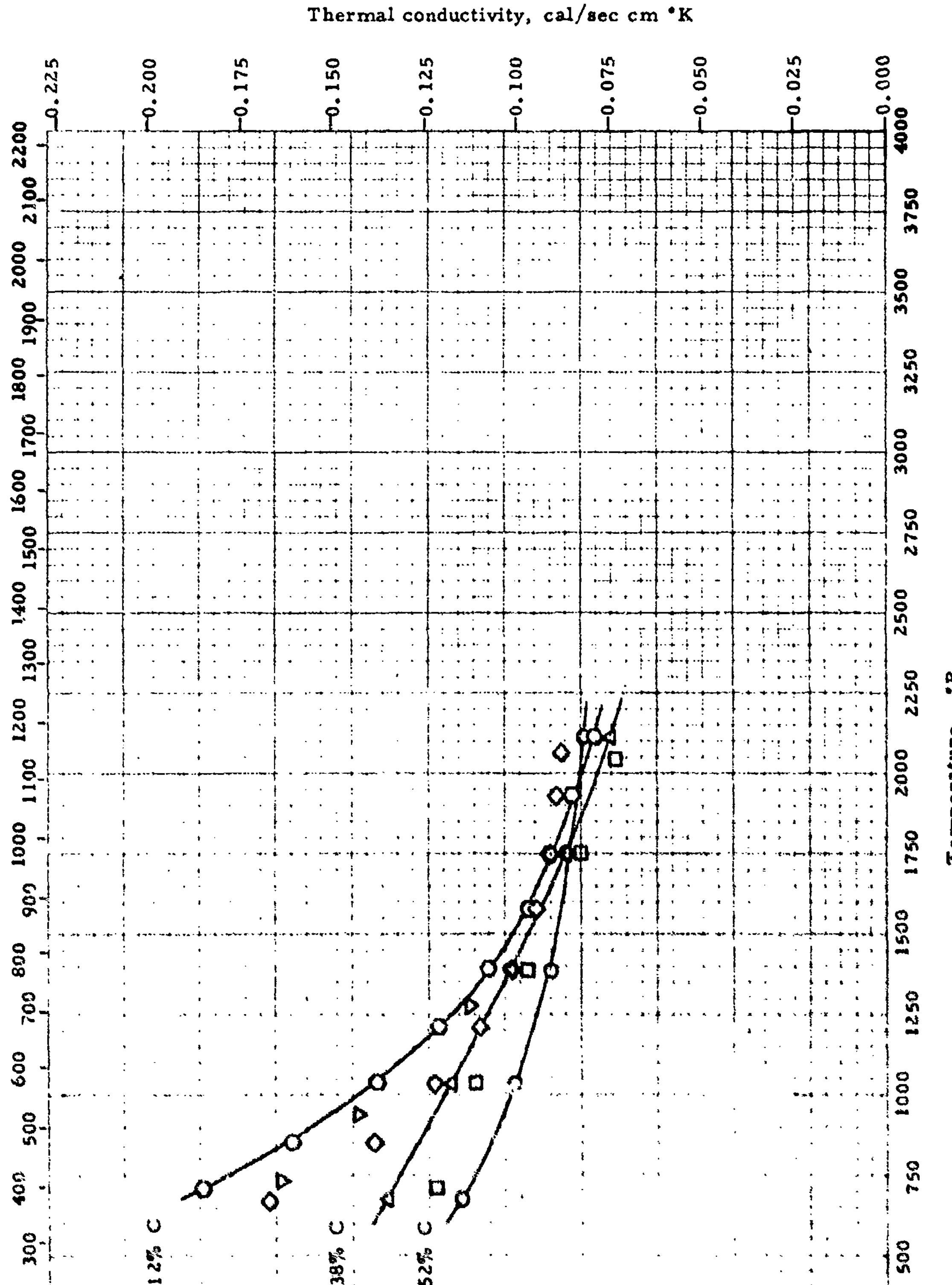


THERMAL CONDUCTIVITY -- GRAY CAST IRON, PEARLITIC

THERMAL CONDUCTIVITY -- GRAY CAST IRON, PEARLITIC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovskii, B.B., and Gel'd, P.V.	56-35	735-2148	2.33% C; 1.29% Si; 1.20% C_{comb}; 0.36% Mn; 0.143% P; 0.10% Ni; 0.69% S; 0.06% Cr	Radial heat flow in cylinder	Auth. est. accuracy ± 5%
□	Ibid.	56-35	735-2148	2.98% C; 1.94% Si; 1.5% Mn; 0.75% C_{comb}; 0.490% Cr; 0.456% P; 0.130% Ni; 0.077% S	Same as above	Same as above
△	Ibid.	56-35	735-2148	3.05% C; 1.82% Si; 0.91% Mn; 0.85% C_{comb}; 0.65% W, 0.509% P; 0.42% Cr; 0.090% Ni; 0.083% S	Same as above	Same as above
◇	Ibid.	56-35	735-2148	3.20% C; 2.25% Si; 0.88% Mn; 0.61% C_{comb}; 0.143% P; 0.116% S; 0.10% Ni; 0.09% Cr	Same as above	Same as above
▽	Ibid.	56-35	735-2148	3.82% C; 2.02% Si; 0.95% Mn; 0.65% C_{comb}; 0.484% P; 0.9% Cr; 0.15% Ni; 0.090% S	Same as above	Same as above

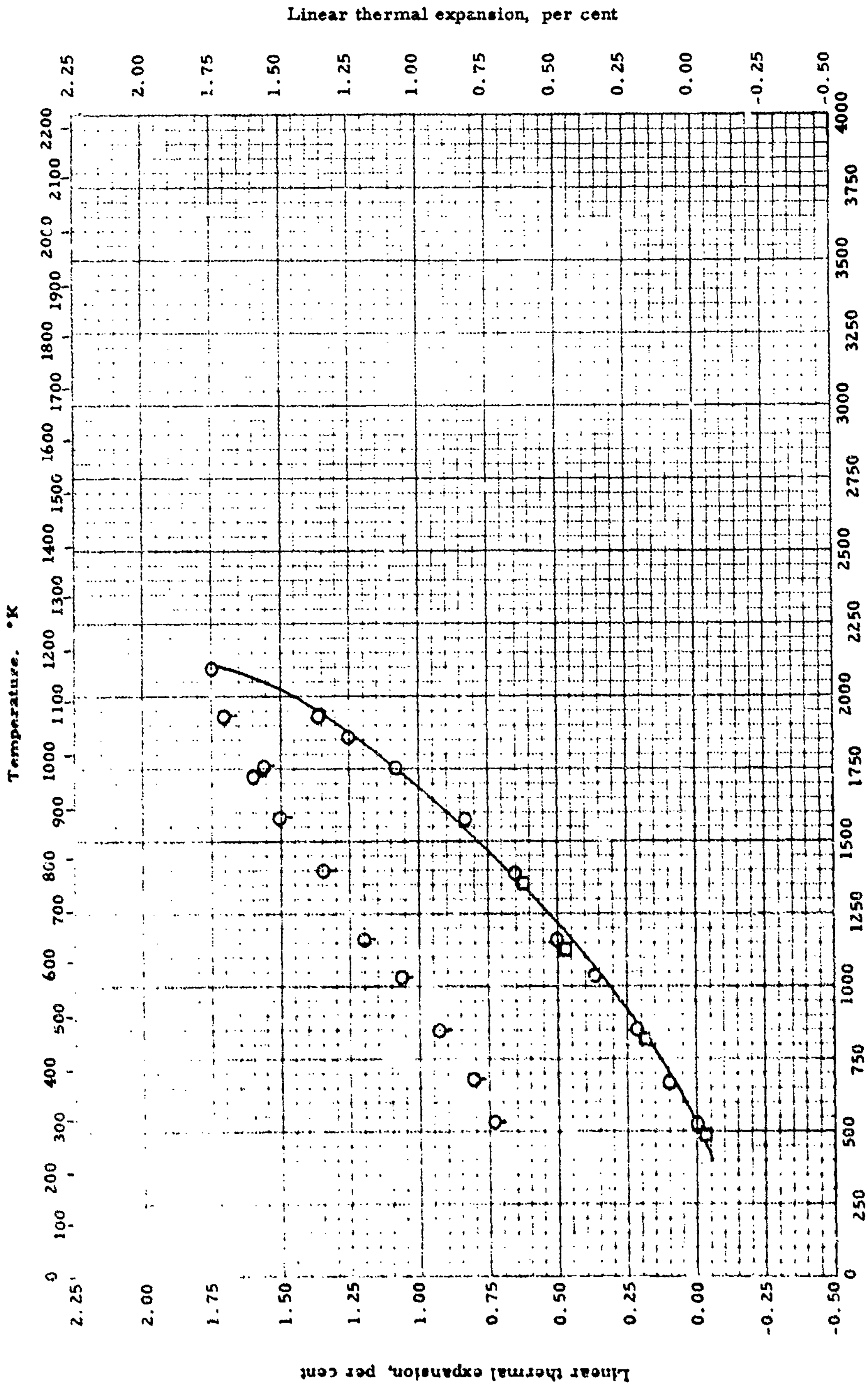


THERMAL CONDUCTIVITY -- GRAY CAST IRON

THERMAL CONDUCTIVITY -- GRAY CAST IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovskii, B.B., and Gel'd, P.V.	56-35	672-2112	2.52% C; 2.35% Si; 0.59% Mn; 0.17% Cr; 0.034% P; 0.022% S	Radial heat flow in cylinder	Samples graphitized at a high temp. to ferrite-graphite structure. Samples contain lameller form of graphite. Auth. est. accuracy ± 5%
□	Ibid.	56-35	708-2040	2.97% C; 2.35% Si; 0.61% Mn; 0.18% Cr; 0.034% P; 0.023% S	Same as above	Same as above
△	Ibid.	56-35	672-2112	3.38% C; 2.33% Si; 0.59% Mn; 0.18% Cr; 0.032% P; 0.020% S	Same as above	Same as above
◇	Ibid.	56-35	672-2053	3.47% C; 2.37% Si; 0.67% Mn; 0.06% Cr; 0.026% P; 0.007% S	Same as above	Same as above
▽	Ibid.	56-35	735-1275	3.69% C; 1.01% Si; 0.83% combined C; 0.69% Mn; 0.28% P; 0.079% S; 0.05% Cr; 0.02% Ni	Same as above	Cast iron with pearlite base. Auth. est. accuracy ± 5%
○	Ibid.	56-35	708-2112	4.12% C; 2.18% Si; 0.58% Mn; 0.082% Cr; 0.024% S; 0.022% P	Same as above	Samples graphitized at a high temp. to ferrite-graphite structure. Samples contain lameller form of graphite. Auth. est. accuracy ± 5%

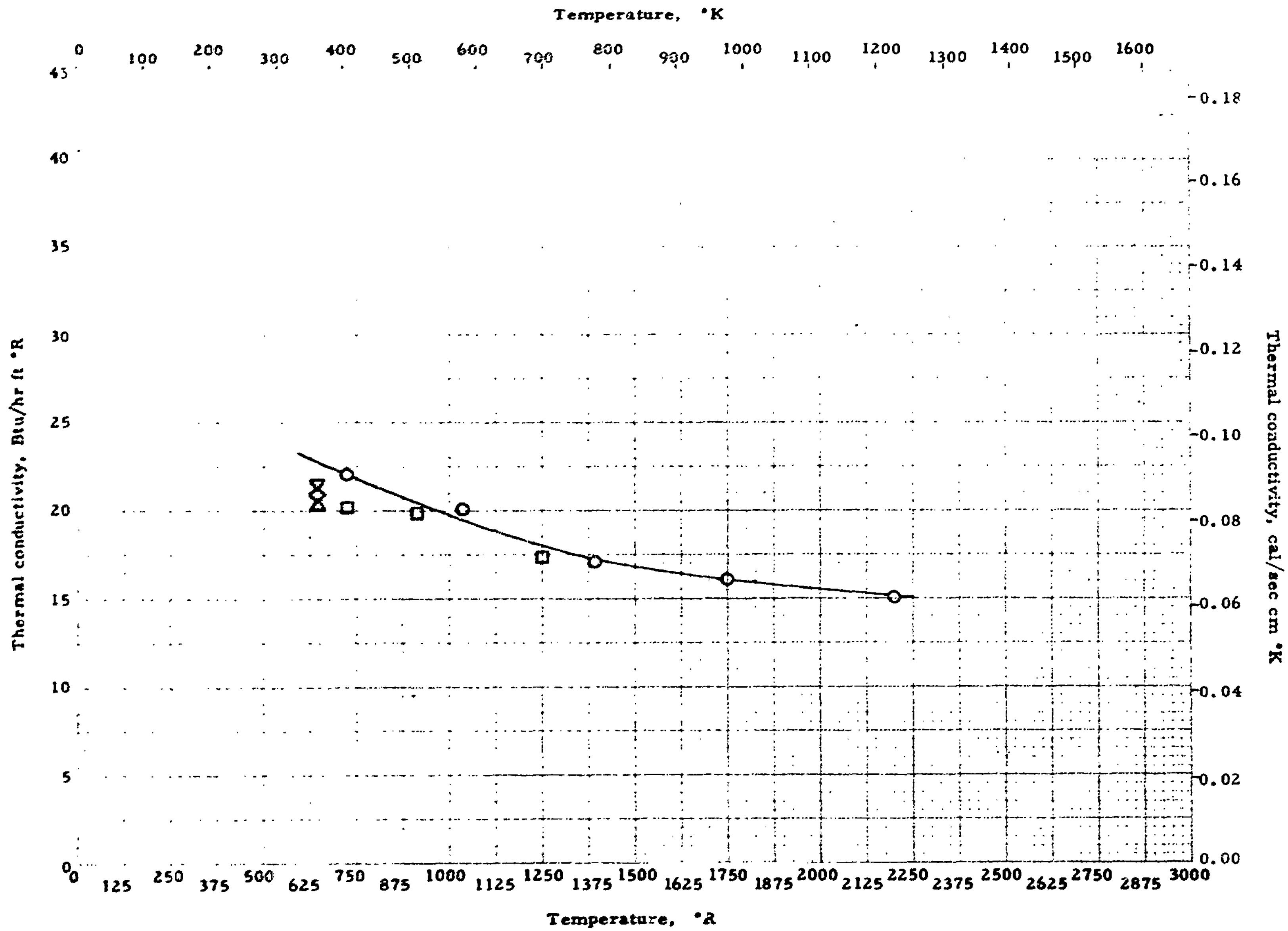


LINEAR THERMAL EXPANSION -- GRAY CAST IRON

LINEAR THERMAL EXPANSION -- GRAY CAST IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dumitrescu, T., Nicolaid, M. and Iliescu, P.	56-82	537-2112	93.74% Fe; 3.55% C; 2.00% Si; 0.55% Mn; 0.119% P; 0.040% S	Recording optical dilatometer	○ : Heating ♀ : Cooling Heating rate 2°C/min. up to 600°C, then 1.5°C/min. Cooling curves higher than heating curves due to internal oxidization and graphitization
□	Cornelius, H.	43-17	528-1392	Three samples: a) 3.46% C; 2.21% Si; 0.97% Mn; 0.43% P; 0.38% Cr; 0.28% Ni; 0.032% S b) 3.59% C; 2.81% Si; 1.56% Cu; 0.93% Mo; 0.59% Mn; 0.55% Cr; 0.51% P; 0.09% V; 0.43% S c) 3.97% C; 2.86% Si; 0.69% P; 0.65% Mn; 0.25% Mo; 0.035% S		Points shown are mean values with 1.0% max. deviation



THERMAL CONDUCTIVITY -- NODULAR CAST IRON, FERRITIC

REFERENCE INFORMATION

<table>
<tr><th>Symbol</th><th>Investigator</th><th>Ref.</th><th>Range, °R</th><th>Material Composition</th><th>Test Method</th><th>Remarks</th></tr>
<tr><td>○</td><td>Kuprovskii, B. B., and Gel'd, P. V.</td><td>56-35</td><td>726-2202</td><td>5 samples of following comp. in wt %
<table>
<tr><th>C</th><th>Si</th><th>Mn</th><th>Cr</th><th>P</th><th>S</th><th>Mg</th></tr>
<tr><td>3.57</td><td>2.44</td><td>0.61</td><td>0.082</td><td>0.020</td><td>0.003</td><td>0.011</td></tr>
<tr><td>3.34</td><td>2.53</td><td>0.81</td><td>0.10</td><td>0.024</td><td>0.005</td><td>1.0</td></tr>
<tr><td>3.32</td><td>2.49</td><td>0.59</td><td>0.17</td><td>0.035</td><td>0.005</td><td>0.016</td></tr>
<tr><td>2.78</td><td>2.48</td><td>0.63</td><td>0.18</td><td>0.033</td><td>0.006</td><td>0.004</td></tr>
<tr><td>2.52</td><td>2.55</td><td>0.59</td><td>0.18</td><td>0.035</td><td>0.003</td><td>0.016</td></tr>
</table></td><td>Radial heat flow in cylinder</td><td>Auth. reports same data for all samples, est. accuracy + 5%; samples graphitized at high temp. to ferrite-graphite structure. Samples are Mg modified and contain spheroidal form of graphite</td></tr>
<tr><td>□</td><td>Ibid.</td><td>56-35</td><td>726-1242</td><td>2.95% C; 2.90% Si; 1.08% Mn; 0.75% combined C; 0.18% Ni; 0.126% P; 0.08% Mg; 0.02% Cr; 0.01% S</td><td></td><td></td></tr>
<tr><td>△</td><td>Sinnott, M. J.</td><td>53-86</td><td>620-670</td><td>4.34% Si; 3.36% C; 1.23% Ni; 0.040% Mn; 0.06% Mg; 0.030% P; 0.010% S. 85% ferrite; 5% pearlite; 10% graphite</td><td>Comparative; rods</td><td>As cast. Graphite size 0.00081 in.</td></tr>
<tr><td>◇</td><td>Ibid.</td><td>53-86</td><td>620-670</td><td>3.53% Si; 3.47% C; 1.30% Ni (est.); 0.20% Mn; 0.06% Mg; 0.030% P; 0.012% S. 55% ferrite; 35% pearlite; 9% graphite</td><td>Same as above</td><td>As cast. Graphite size 0.00096 in.</td></tr>
<tr><td>▽</td><td>Ibid.</td><td>53-86</td><td>620-670</td><td>3.56% C; 2.27% Si; 1.30% Ni (est.); 0.33% Mn; 0.06% Mg (est.); 0.025% P; 0.010% S. 50% ferrite; 40% pearlite; 10% graphite</td><td>Same as above</td><td>As cast. Graphite size 0.000121 in.</td></tr>
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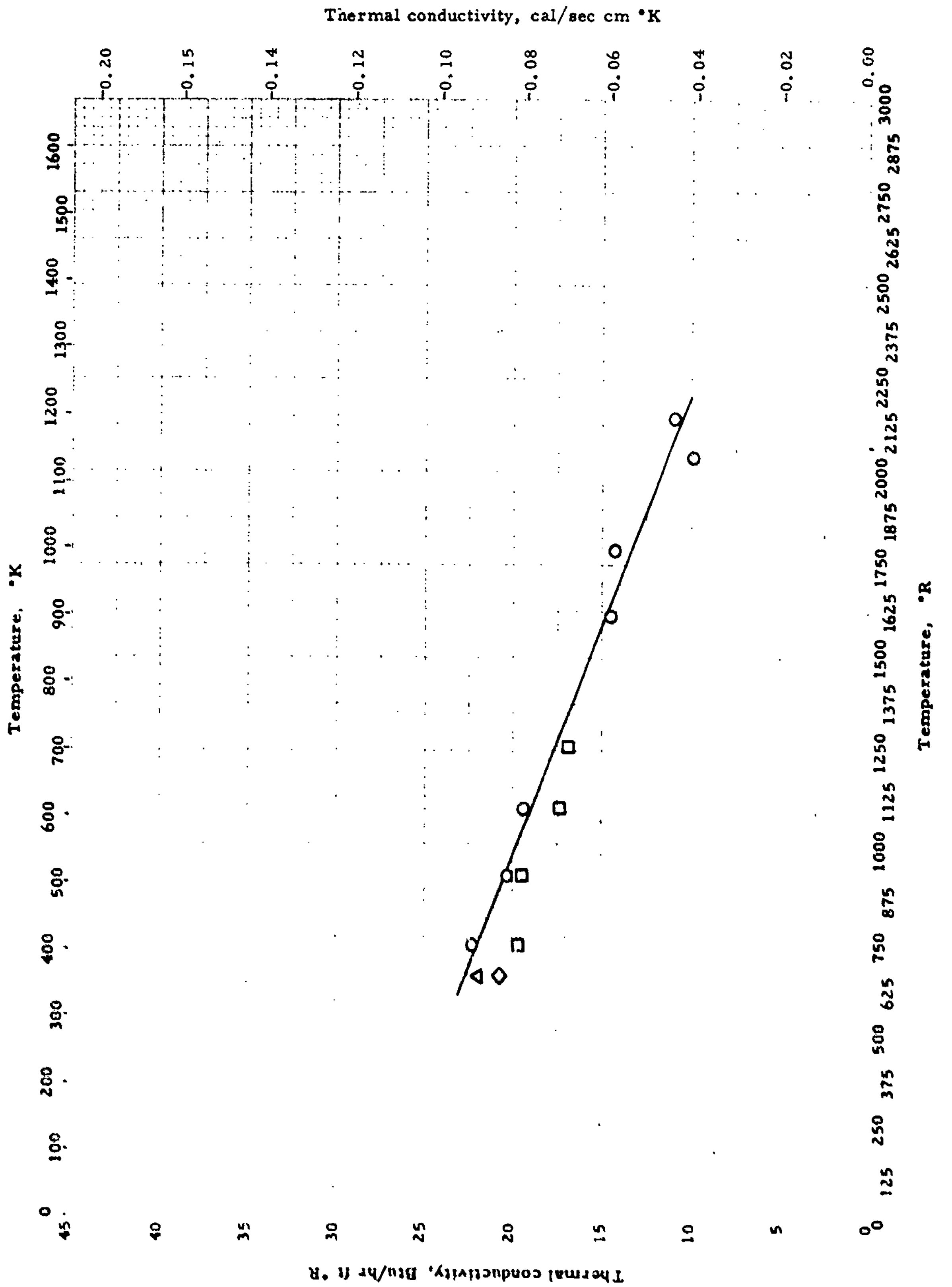
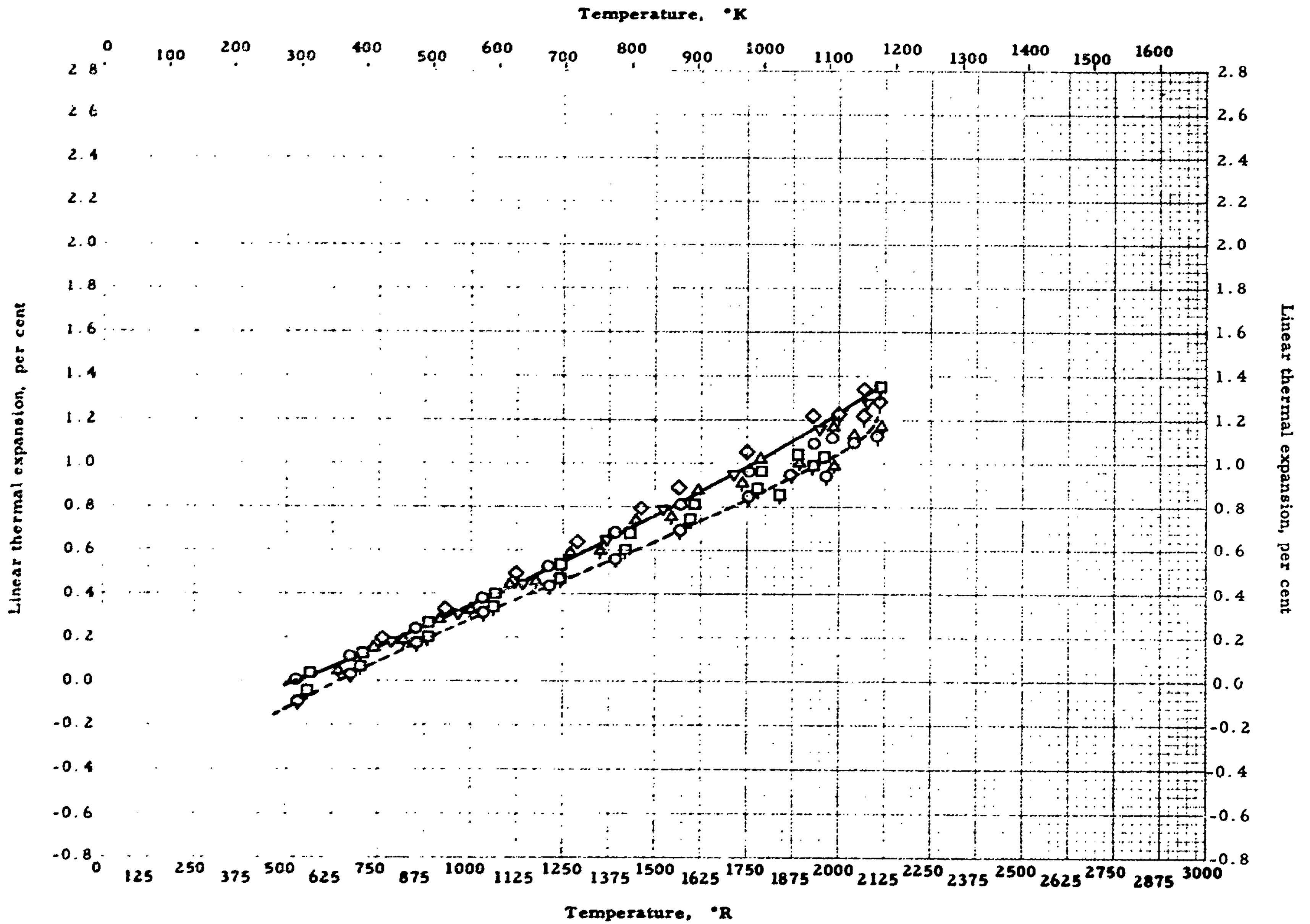


THERMAL CONDUCTIVITY -- NODULAR CAST IRON, PEARLITIC

THERMAL CONDUCTIVITY -- NODULAR CAST IRON, PEARLITIC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovskii, B.B. and Gel'd, P. V.	56-35	726-2148	3.13% C; 2.54% Si; 0.91% Mn; 0.81% combined C; 0.15% Ni; 0.122% P; 0.07% Mg; 0.02% Cr; 0.01% S	Radial heat flow in cylinder	Auth. est. accuracy ± 5%
□	Ibid.	56-35	726-1257	2.95% C; 2.90% Si; 1.08% Mn; 0.75% combined C; 0.18% Ni; 0.126% P; 0.08% Mg; 0.02% Cr; 0.01% S	Same as above	Same as above
△	Sinnott, M. J.	53-86	620-670	3.57% C; 1.33% Ni; 1.12% Si; 0.33% Mn; 0.035% P; 0.06% Mg (est.); 0.004% S; 61% pearlite; 30% ferrite; 9% graphite	Comparative; rods	
◇	Ibid.	53-86	620-670	3.33% C; 2.28% Si; 1.12% Ni; 0.50% Mn; 0.06% Mg; 0.055% P; 0.010% S; 85% pearlite; 5% ferrite; 10% graphite	Same as above	

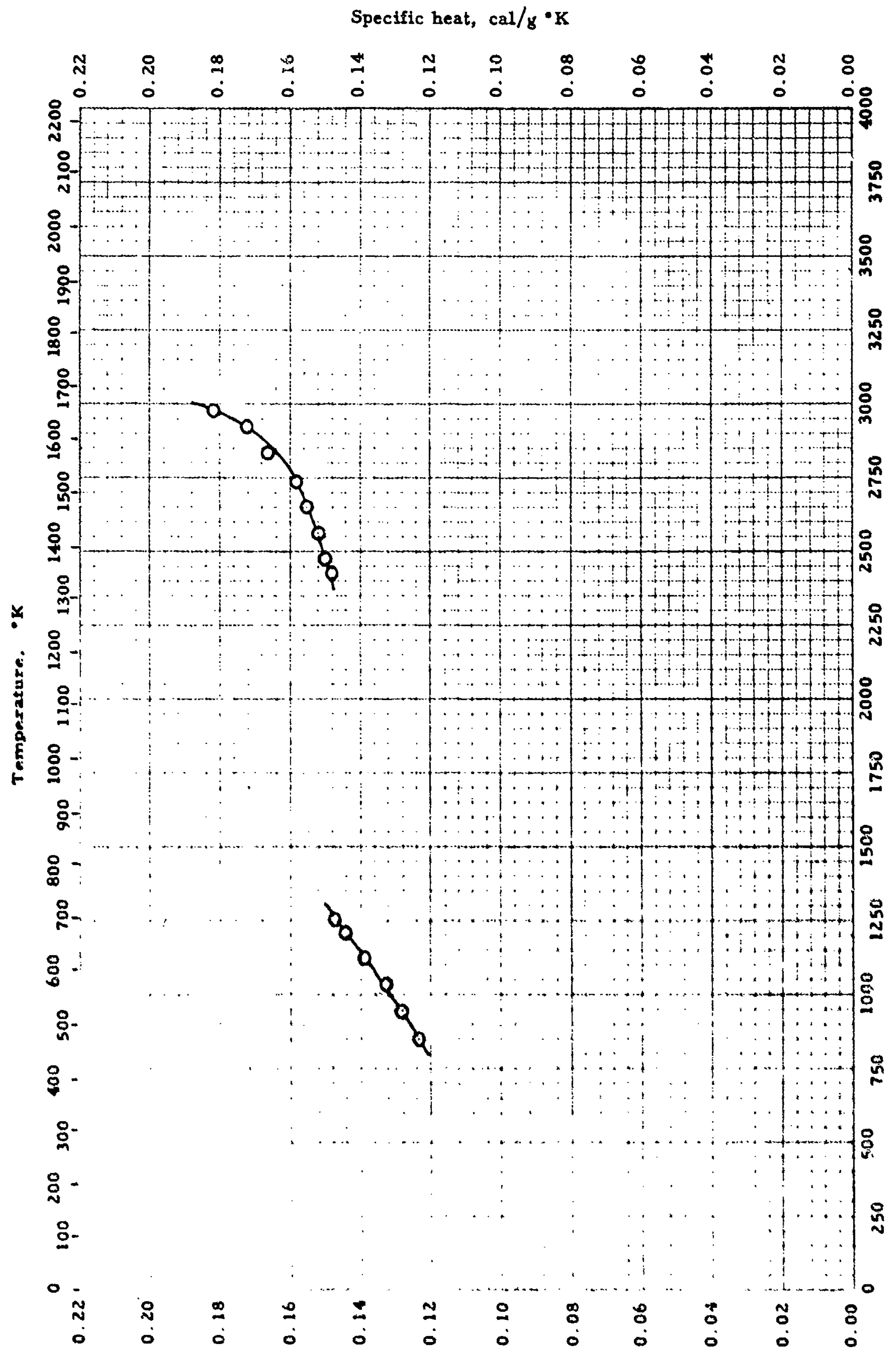


LINEAR THERMAL EXPANSION -- NODULAR CAST IRON, PEARLITIC

LINEAR THERMAL EXPANSION -- NODULAR CAST IRON, PEARLITIC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dumitrescu, T., Nicolaid, M. and Iliescu, P.	56-82	537-2103	Nodular cast iron: 9[illegible].95% Fe; 3.35% C; 2.00% Si; 0.56% Mn, 0.112% P; 0.024% S	Leitz-Wetzlar optical dilatometer with automatic plotting. Heating rate 2°C/min. to 600°C, then 1.5°C/min.	Permanent contraction 0.090% ○ - heating ○ - cooling
□	Ibid.	56-82	537-2112	Nodular cast iron: 93.27% Fe; 3.25% C; 2.80% Si; 0.54% Mn, 0.112% P; 0.024% S	Same as above	Permanent contraction 0.045% □ - heating □ - cooling
△	Ibid.	56-82	537-2112	Nodular cast iron: 92.06% Fe; 4.25% Si; 3.00% C; 0.56% Mn; 0.110% P; 0.018% S	Same as above	Permanent contraction 0.03% △ - heating △ - cooling
◇	Ibid.	56-82	537-2112	Nodular cast iron: 91.49% Fe; 5.04% Si; 2.63% C; 0.72% Mn; 0.105% P; 0.020% S	Same as above	Permanent contraction 0.018%. Auth. gives additional cooling data (◇) which is indistinguishable from heating data when plotted
▽	Ibid.	56-82	537-2112	Nodular cast iron: 91.26% Fe; 5.65% Si; 2.34% C; 0.62% Mn; 0.110% P; 0.022% S	Same as above	Permanent contraction 0.010% Auth. gives cooling data (▽) which is indistinguishable from heating data when plotted

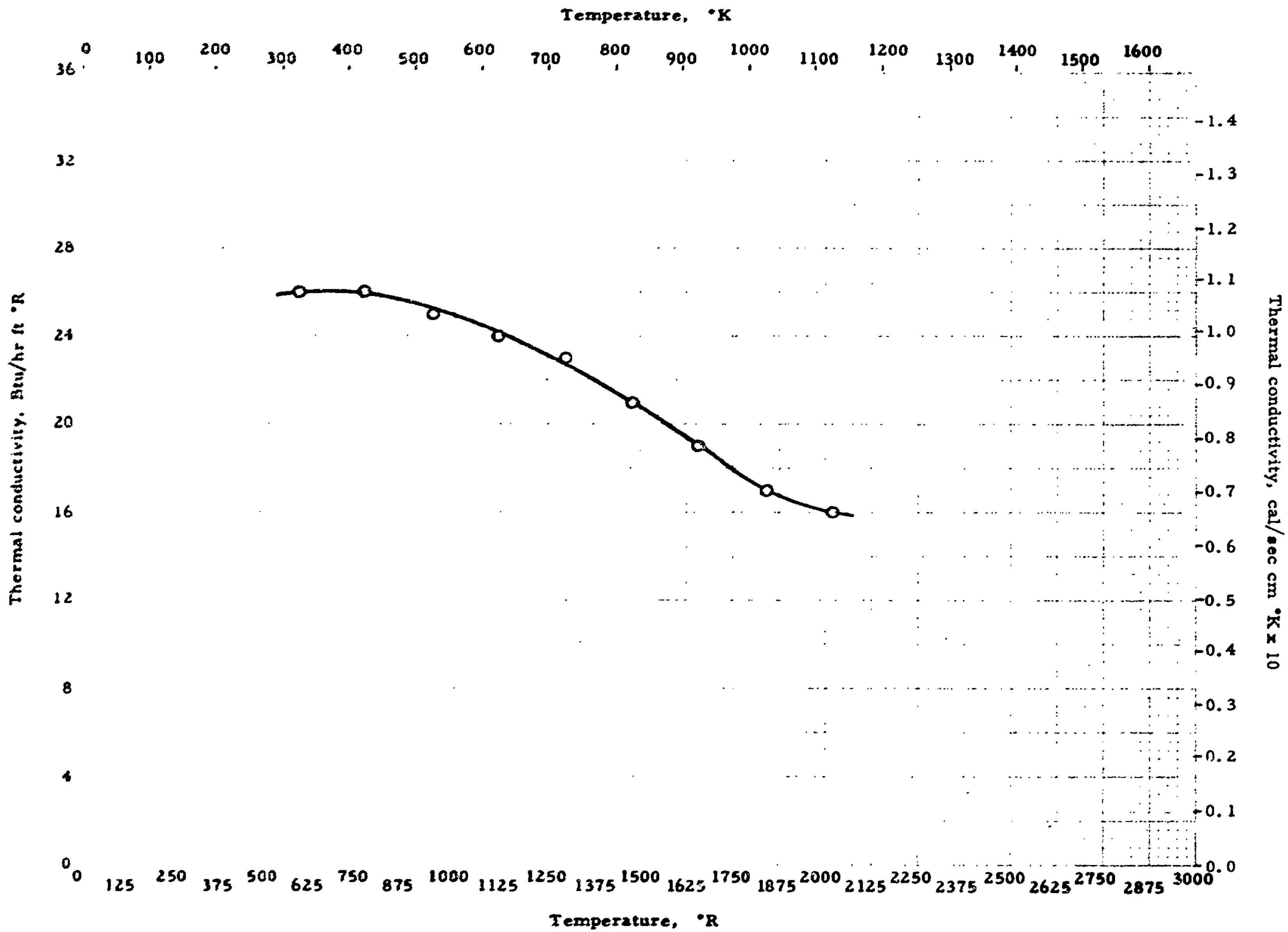


SPECIFIC HEAT -- IRON + NICKEL

SPECIFIC HEAT -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Zuithoff, A. C.	40-7	852-1257 2427-2967	90.9% Fe; 9.1% Ni; prepared from electrolytically deposited raw materials	Drop method	Vacuum melted, heated 5 hr. at 1100°C, cooled slowly. Auth. gives mean c_p over entire range 852 - 2967°R. Transformations in intermediate region prohibit calculation of true c_p

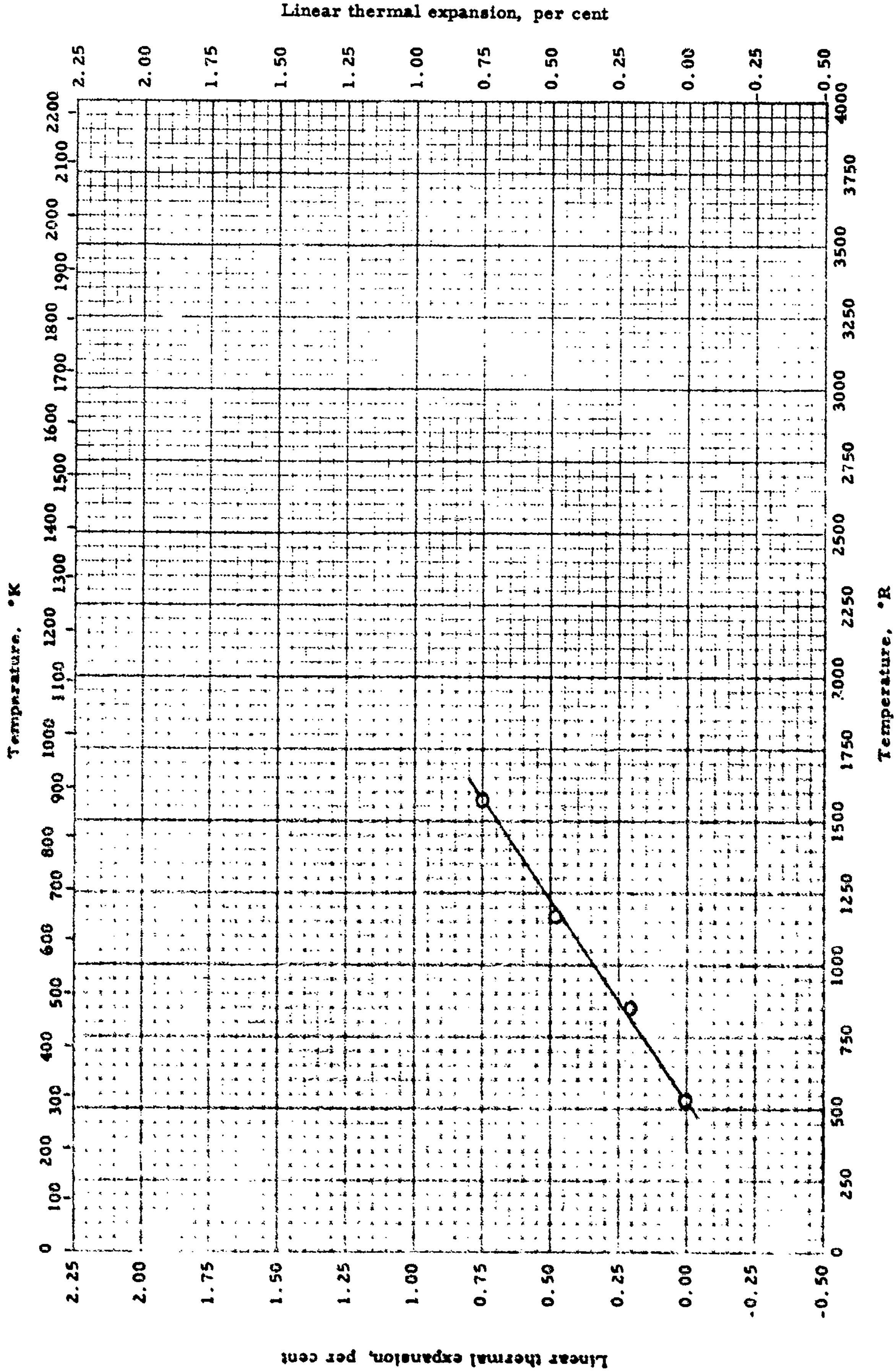


THERMAL CONDUCTIVITY -- IRON + NICKEL

THERMAL CONDUCTIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. W. and Tye, R. P.	56-121	580-2020	Steel EN8, (British Desig.) 1.05% Mn; 0.39% C; 0.14% Si; 0.12% Ni; 0.043% S; 0.032% P	Comparative; rods	Normalized

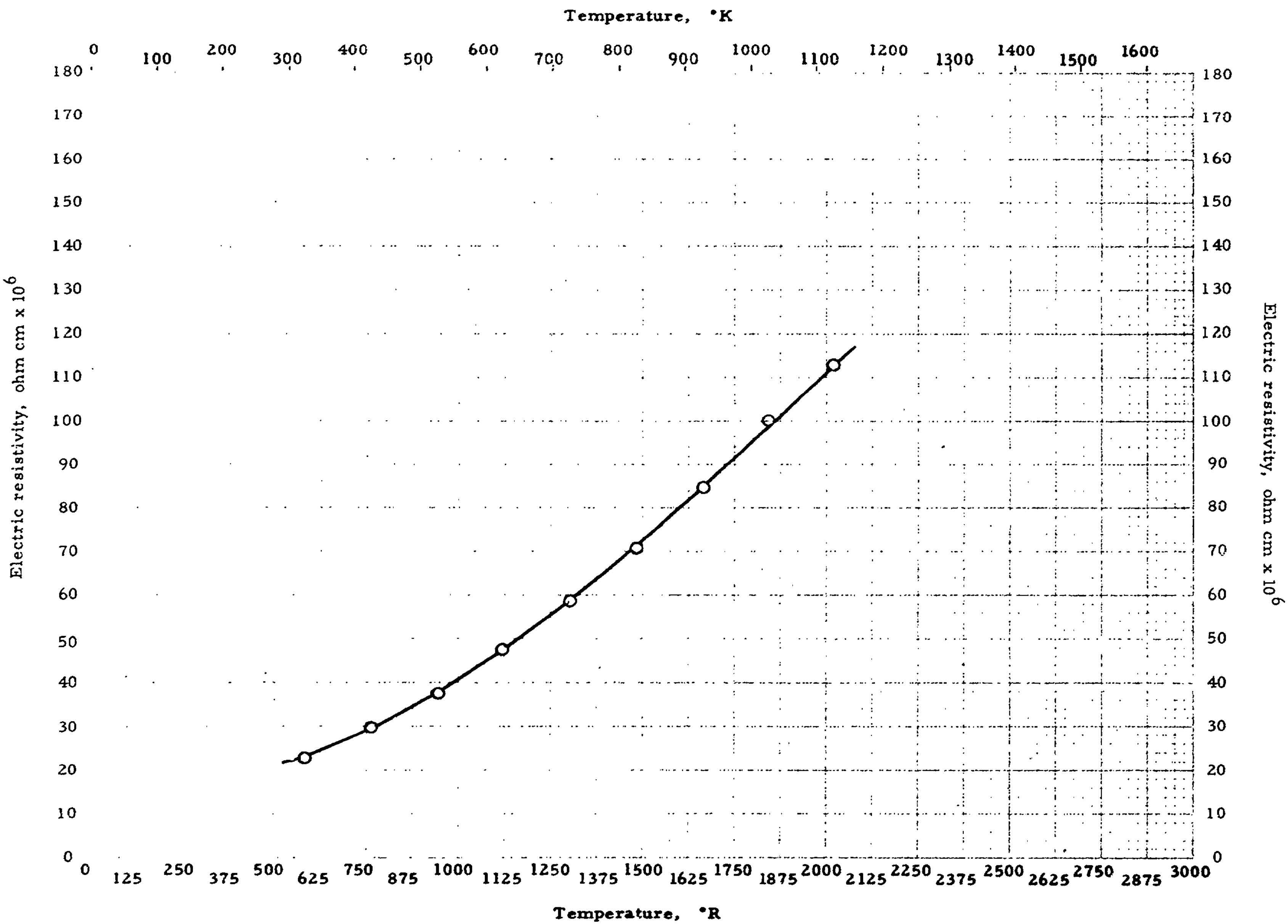


LINEAR THERMAL EXPANSION -- IRON + NICKEL

LINEAR THERMAL EXPANSION -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H.	43-17	528-1932	5.24% Ni; 0.66% Mn; 0.22% Si; 0.014% P; 0.011% S; 0.08% C	Bollenrath dilatometer	Heated at 1.5°C/min. in vacuum

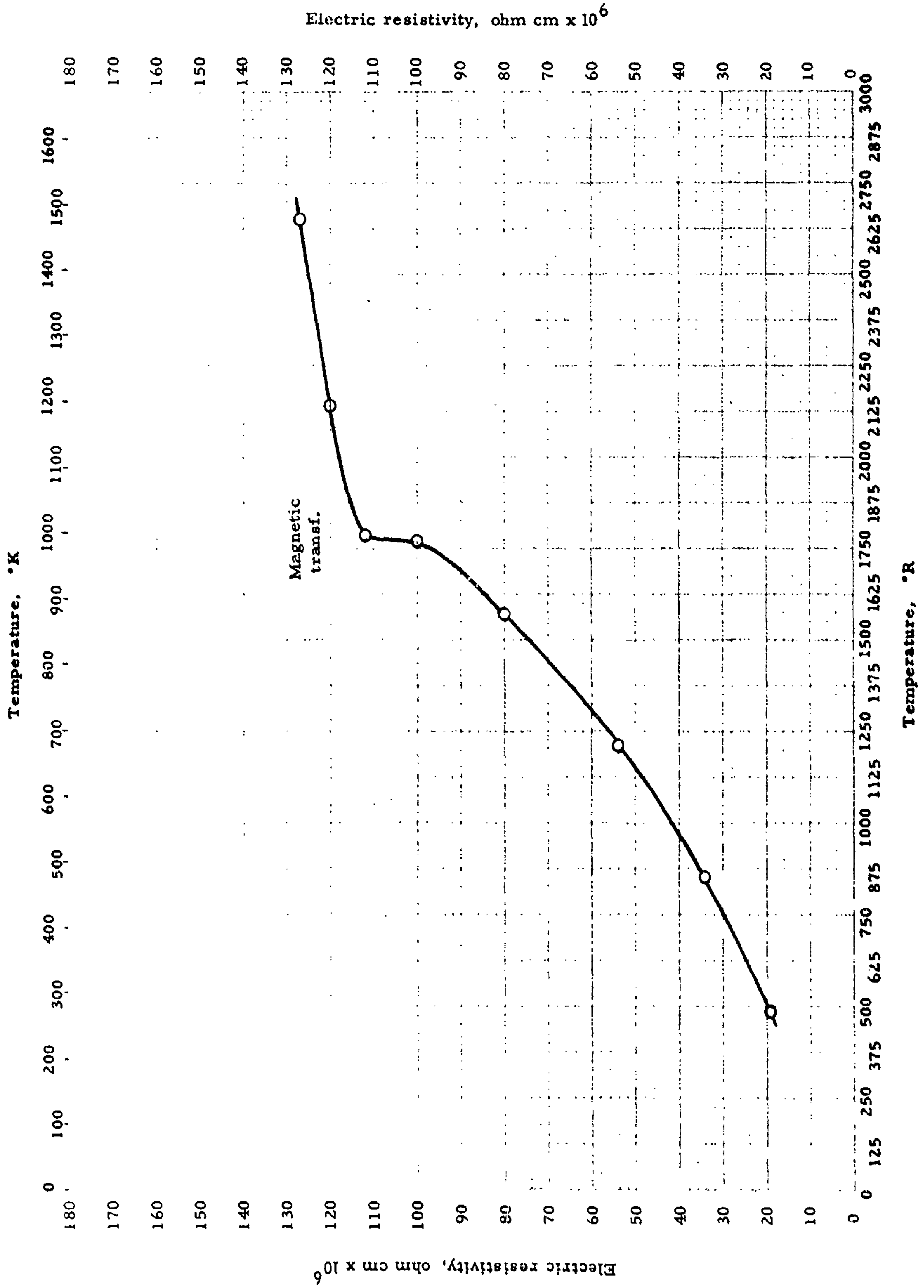


ELECTRIC RESISTIVITY -- IRON + NICKEL

ELECTRIC RESISTIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. W. and Tye, R. P.	56-121	580-2020	Steel. Type EN8 (British desig.): 1.05% Mn; 0.39% C; 0.14% Si; 0.12% Ni; 0.043% S; 0.032% P	Potential drop	Normalized

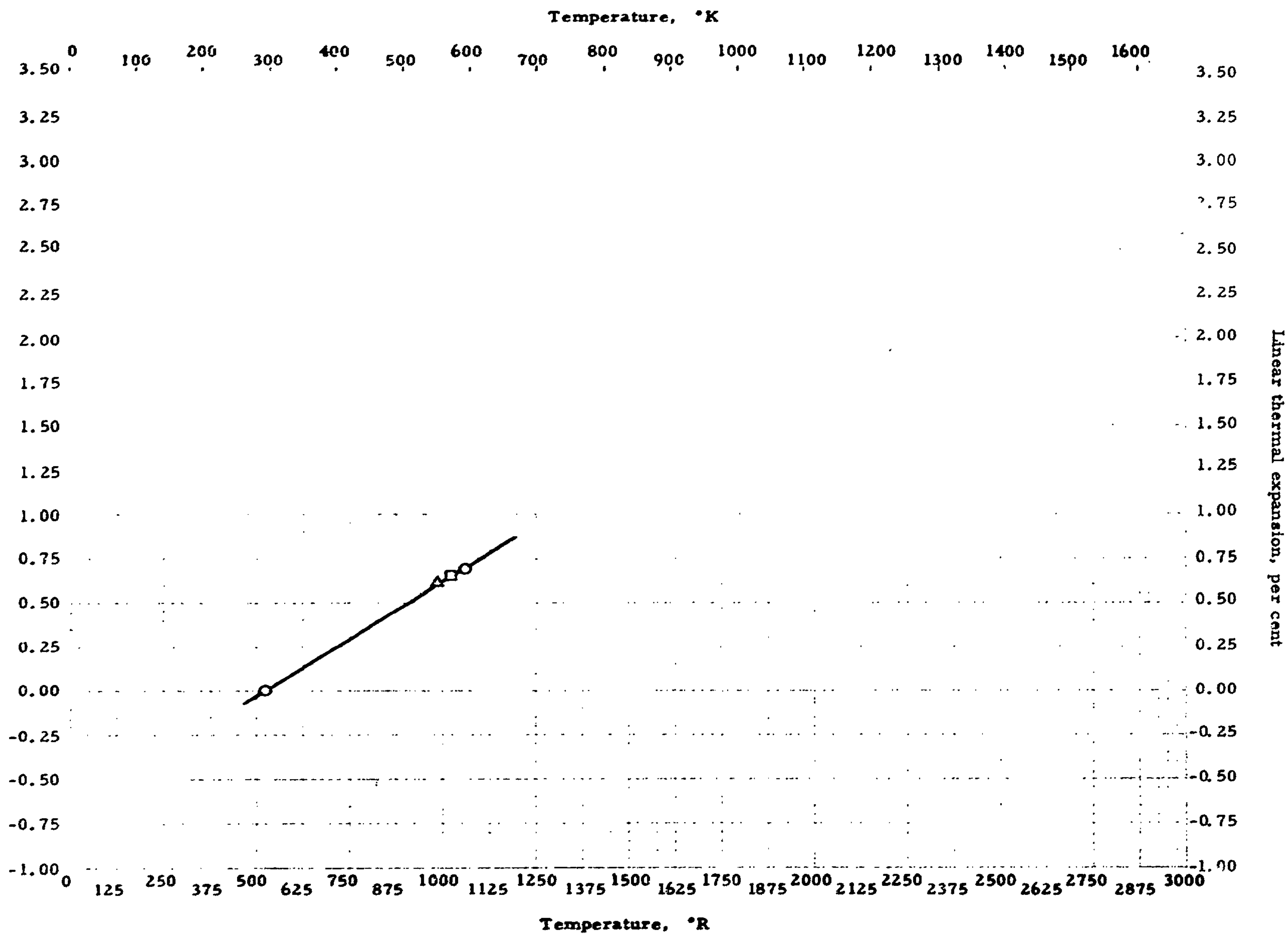


ELECTRIC RESISTIVITY -- IRON + NICKEL + CHROMIUM + X

ELECTRIC RESISTIVITY -- IRON + NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W.	56-124	492-2652	1.22% C; 0.35% Mn; 0.16% Si; 0.13% Ni; 0.11% Cr; 0.077% Cu; 0.015% S; 0.01% Mo; 0.0009% P	Potential drop. Temp. by chromel-alumel thermocouple	Annealed at 800°C-930°C

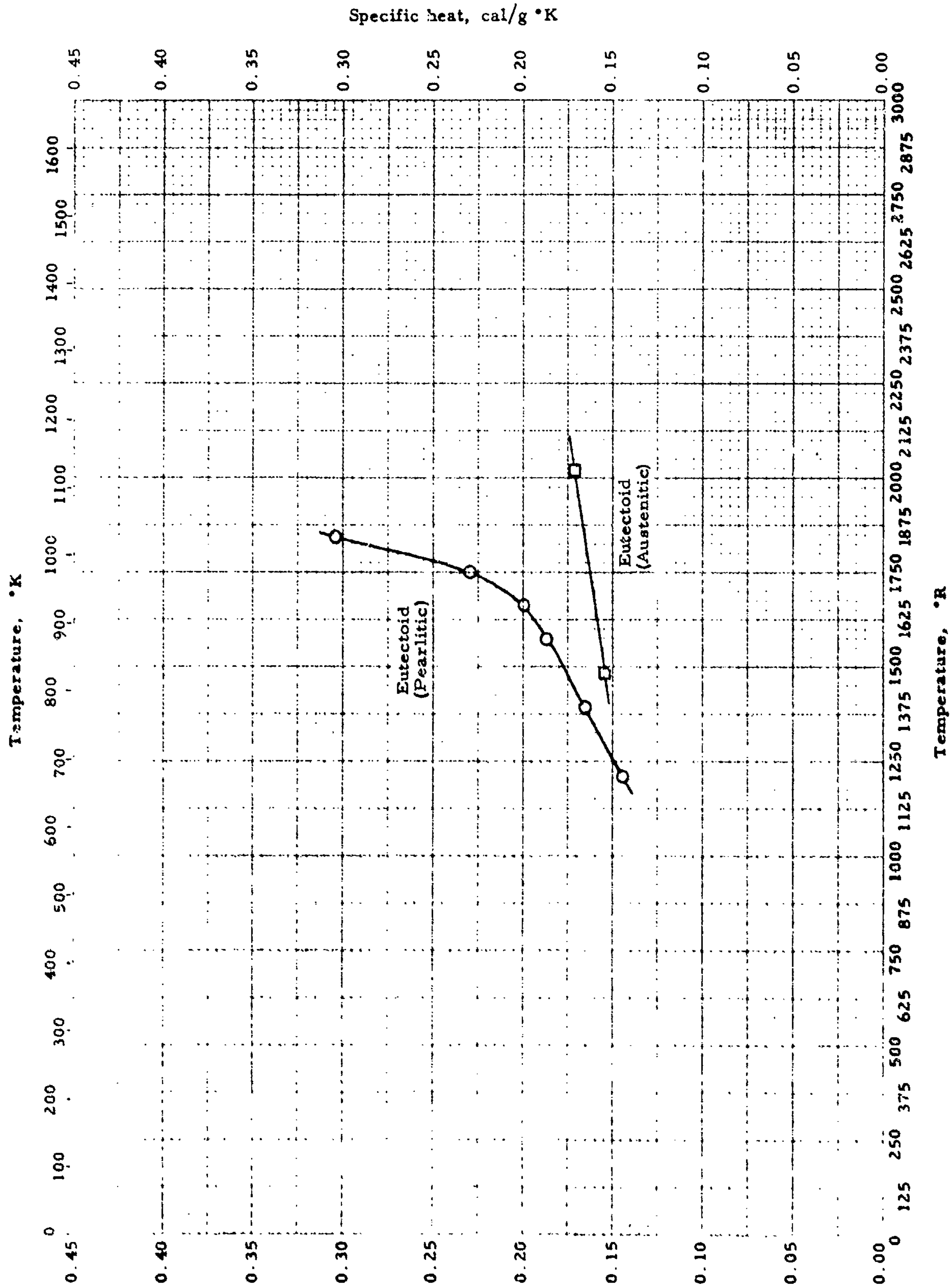


LINEAR THERMAL EXPANSION -- IRON + NICKEL + X

LINEAR THERMAL EXPANSION -- IRON + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Payson, P.	56-80	530-1060	Austenitic Steel: 6.1% Ni; 5.2% Mn; 0.55% C; 0.11% Si	Not given	Air cooled from 2100 °F
□	Ibid.	56-80	530-1060	Austenitic Steel: 8.9% Ni; 5.3% Mn; 0.59% C; 0.31% Si; 0.05% Cr	Same as above	Same as above
△	Ibid.	56-80	530-1060	Austenitic Steel: 8.8% Ni; 8.8% Mn; 0.57% C; 0.33% Si; 0.07% Cr	Same as above	Same as above

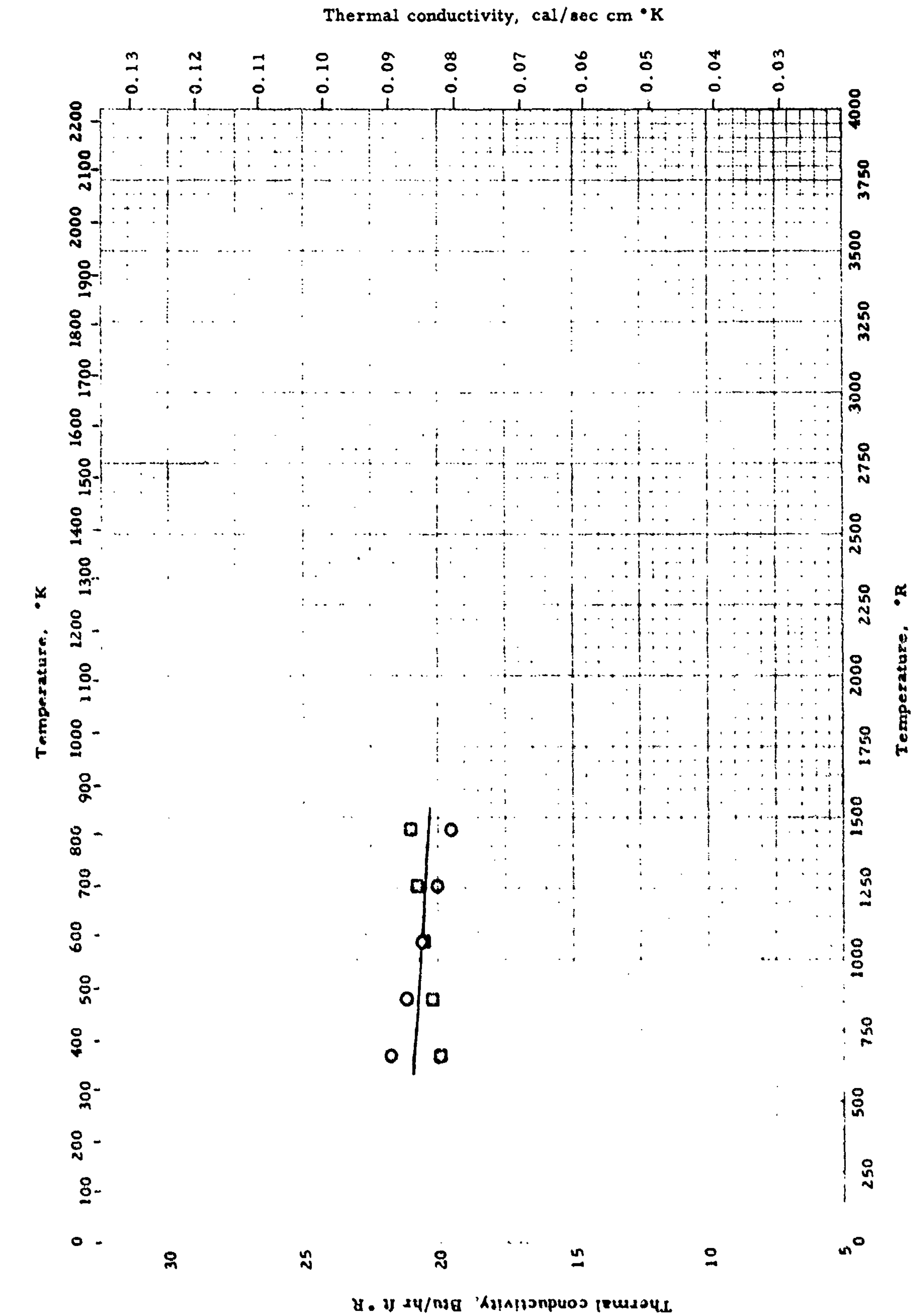


SPECIFIC HEAT -- IRON + MOLYBDENUM + X

SPECIFIC HEAT -- IRON + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hagel, W. C., Pound, G. M., and Mehl, R. F.	54-9	1212-1842	Eutectoid Steel Alloy; 0.79% C; 0.51% Mo; 0.19% Si; 0.12% Mn; 0.005% ea. S, P; Pearlitic	Comparative; rate of temp. rise in sample compared with standard under same heating condition	
□	Ibid.	54-9	1482-2202	Same compos. as above; Austenitic	Same as above	

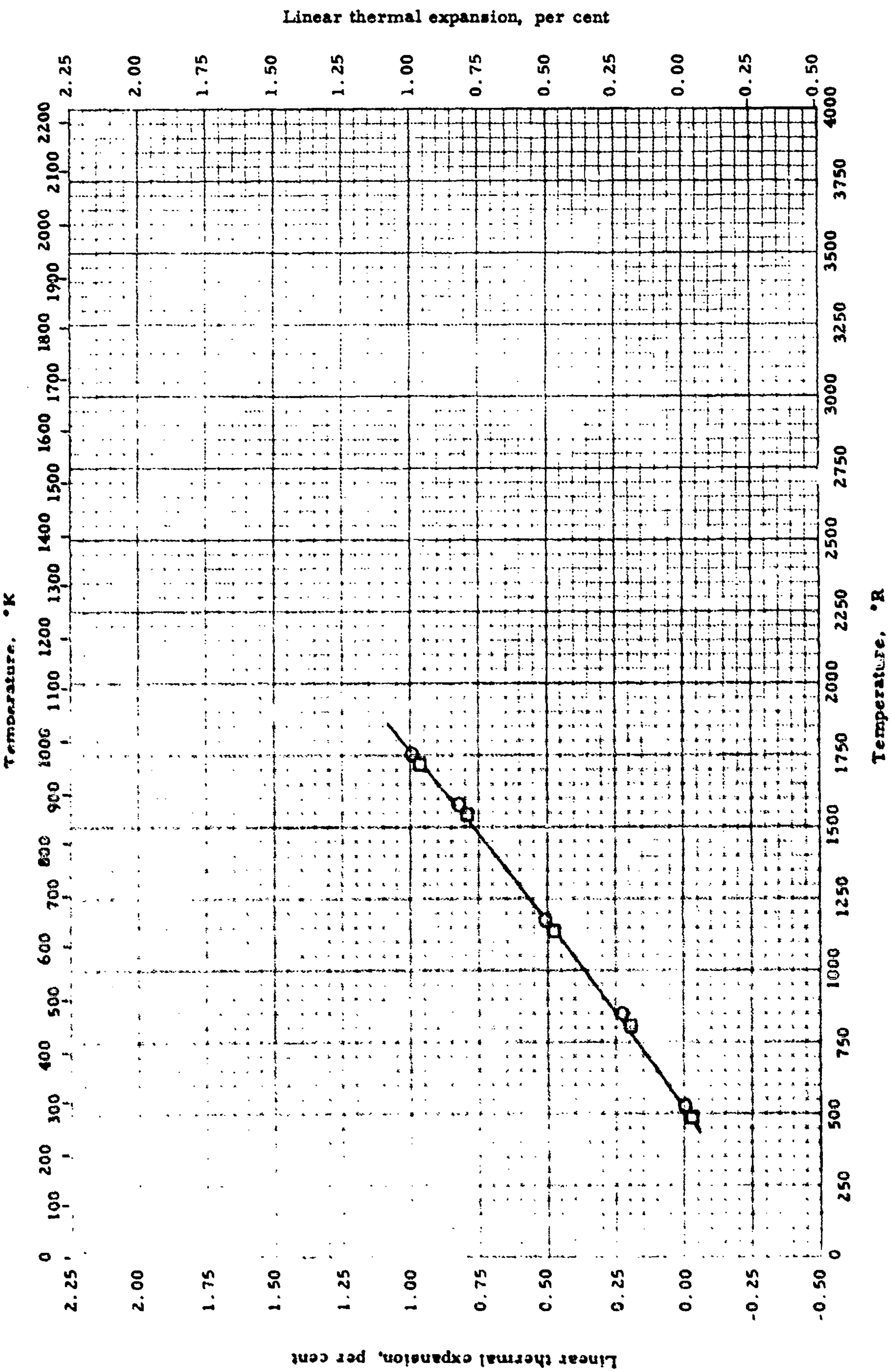


THERMAL CONDUCTIVITY -- IRON + MOLYBDENUM + CHROMIUM + X

THERMAL CONDUCTIVITY -- IRON + MOLYBDENUM + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Loewen, E. G.	56-21	660-1460	High speed steel (M1); 85% Fe; 8.5% Mo; 4% Cr; 1.5% W; 1% V	Axial heat flow in rod; calorimeter sink; guarded sample	Auth. est. accuracy ± 7-10%
□	Ibid	56-21	660-1460	High speed steel (M-10); 8% Mo; 4% Cr; 2% V	Same as above	Same as above



LINEAR THERMAL EXPANSION -- IRON + MOLYBDENUM + X

LINEAR THERMAL EXPANSION -- IRON + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H.	43-17	528-1752	1.49% Mo; 0.69% Mn; 0.28% Si; 0.09% C; 0.018% S; 0.012% P	Bollenrath dilatometer	
□	Ibid.	43-17	528-1752	0.55% Mo; 0.66% Mn; 0.27% Si; 0.08% C; 0.016% S; 0.009% P	Same as above	

PROPERTIES OF IRON + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 94% Fe	490 lb_m/ft^3	7.83 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	489	7.83
	□	489	7.83

	°R	°K
Melting Point:		

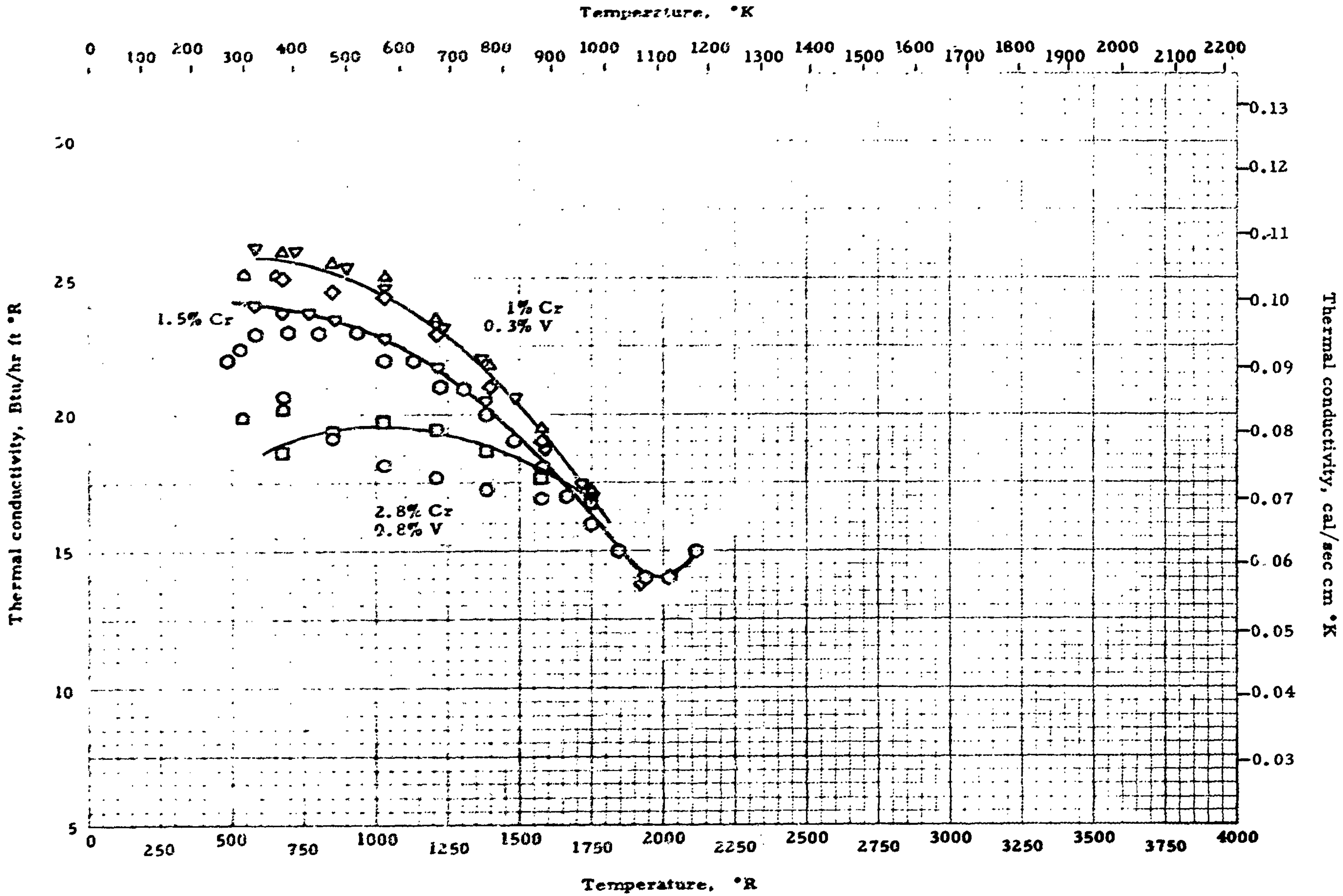
	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

REFERENCE INFORMATION

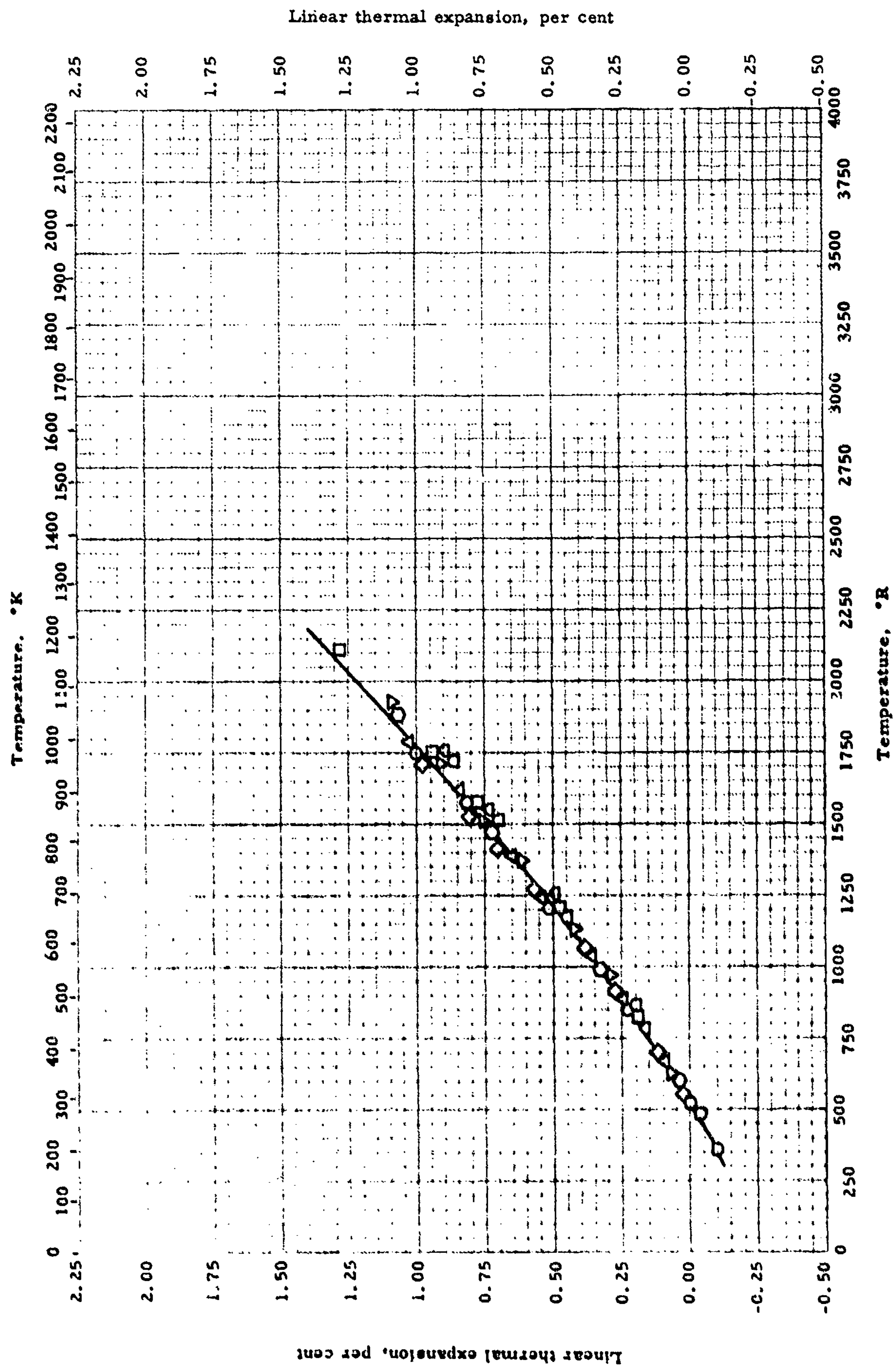
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Colbeck, E. W. and Rait, J. R.	56-26	Room	H. G. T. 3 steel (British desig.): 2.87% Cr; 0.77% V; 0.59% W; 0.51% Mo; 0.45% Si; 0.35% Ni; 0.33% Mn; 0.23% C	ρ : not given	
□	Oliver, D. A. and Harris, M. A.	52-25	Room	Jessop No. 40 steel (British desig.) 2.7% Cr; 0.75% V; 0.5% ea. Mo, W; 0.45% Si; 0.30% ea. Ni, Mn; 0.23% C	ρ : not given	



THERMAL CONDUCTIVITY -- IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Colbeck, E. W. and Rait, J. R.	52-26	528-1752	H. G. T. 3 Steel (Brit. Desig.); 2.87% Cr; 0.77% V; 0.59% W; 0.51% Mo; 0.45% Si; 0.33% Mn; 0.23% C; 0.35% Ni; ρ = 489 lb_m/ft^3	Not given	
□	Oliver, D. A. and Harris, M. A.	52-25	528-1752	Jessop H 40 Steel (Brit. Desig.); 2.7% Cr; 0.75% V; 0.5% ea. Mo, W; 0.45% Si; 0.30% ea. Ni, Mn; 0.23% C; ρ = 489 lb_m/ft^3	Not given	
△	Neimark, B. E.	55-68	672-1752	1.08% Cr; 0.57% Mn; 0.30% V; 0.26% Si; 0.15% C	Temp. distribution along resistance heated rod	After working
◇	Ibid.	55-68	672-1752	Same as above	Same as above	Heat treated
▽	Powell, R. W. and Tye, R. P.	56-121	582-1482	En 19 Steel (British Desig.); 1.15% Cr; 0.59% Mn; 0.42% C; 0.33% Ni; 0.23% Si; 0.22% Mo; 0.046% P; 0.019% S	Comparative; rods	Oil quenched, annealed 1 hr. at 850 °C, cooled slowly, reheated to 650 °C for 120 hr., cooled slowly
○	Ibid.	56-121	492-2110	En 31 Steel (British Desig.); 1.5% Cr; 1.05% C; 0.73% Mn; 0.23% ea. Ni, Si; 0.21% Mo; 0.030% P; 0.028% S	Above 50 °C: comparative; rods. Below 50 °C: axial heat flow in rod, guarded heat source and sample	Oil quenched from 830 °C, tempered 2 hr. at 750 °C. Sample tested in vac. Radiation losses meas.
⌂	Powell, R. W.	56-61	528-636	0.88% Cr; 0.59% Mn; 0.35% C; 0.26% Ni	Longitudinal heat flow method	Annealed state
◘	Ibid.	56-61	528-636	Same as above	Same as above	Oil quenched and tempered at 100 °C
▽	Ibid.	56-61	582-1932	1.46% Cr; 1.06% C; 0.31% Ni; 0.24% Si; 0.045% Mn; 0.017% P; 0.013% S	Same as above	Annealed



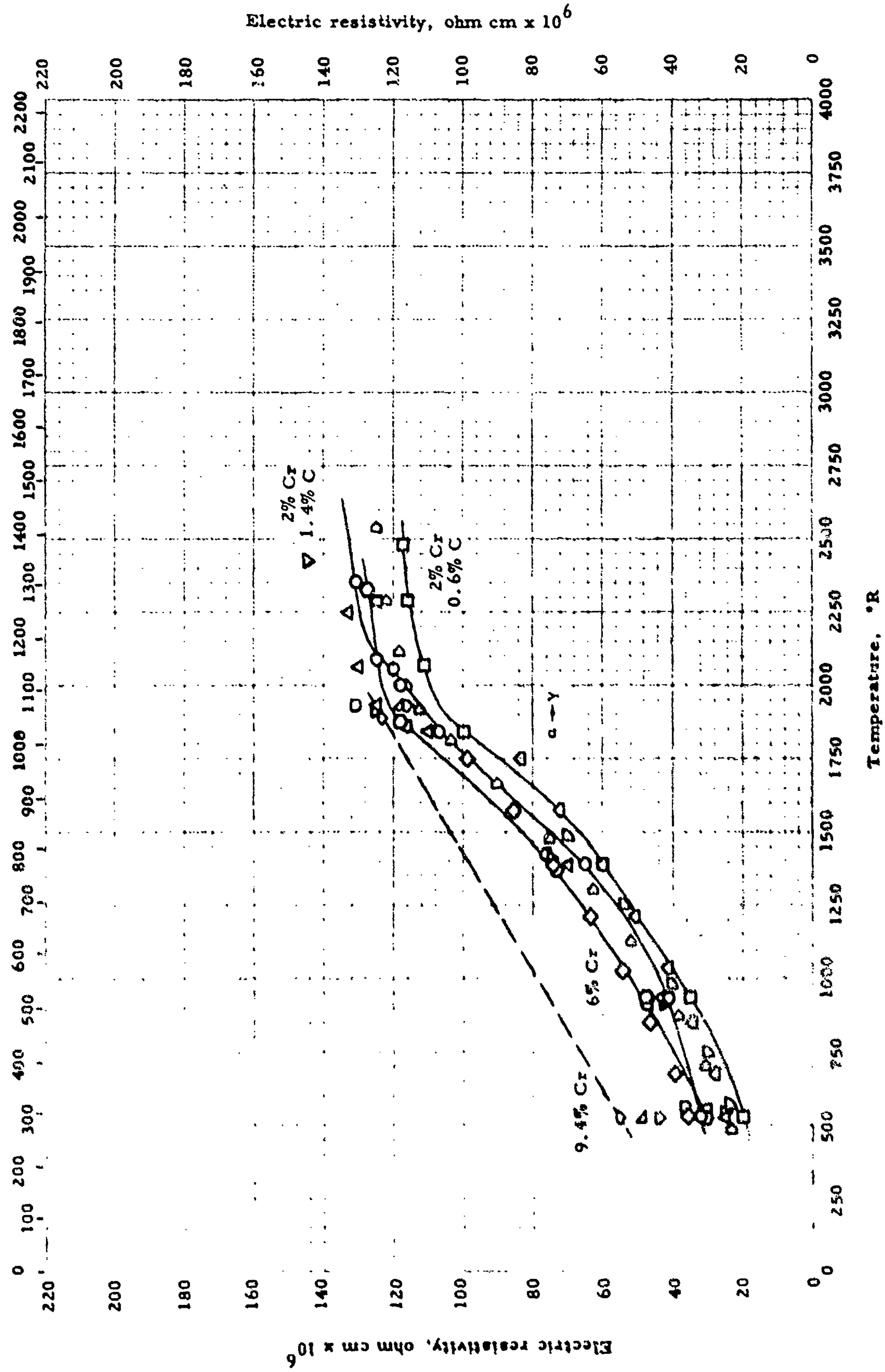
LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H.	43-17	528-2116	9 samples: a) 1.23% Mn; 0.82% Cr; 0.36% Si; 0.12% C b) 1.19% Mn; 0.83% Cr; 0.28% C; 0.18% Si; 0.12% V; 0.019% P; 0.010% S c) 1.05% Cr; 0.64% Mn; 0.48% C; 0.28% Si; 0.18% V; 0.020% P; 0.014% S d) 1.07% Cr; 0.70% Mn; 0.30% Si; 0.26% C; 0.22% Mo; 0.013% Si; 0.011% P e) 1.26% Cr; 1.22% Al; 0.77% Mn; 0.31% C; 0.30% Si; 0.27% Mo f) 1.50% Mn; 1.27% Cr; 0.33% Si; 0.19% C g) 2.38% Cr; 0.74% Mn; 0.30% C; 0.27% V; 0.25% Si; 0.018% P; 0.010% S h) 2.43% Cr; 0.70% Mn; 0.29% Si; 0.28% Mo; 0.25% V; 0.24% C i) 2.48% Cr; 0.68% Mn; 0.27% C; 0.25% Si; 0.21% Mo; 0.19% V; 0.018% P; 0.010% S	Quartz tube dilatometer, Leitz-Bollenrath	Points shown are mean values with 5% max. deviation
□	Ibid.	43-17	528-2112	8 - 12% Cr; 3.0% Si; 0.4 - 0.6% C; 0.5% Mn	Same as above	
△	Neimark, B. E.	55-68	528-1752	4 samples: a) 1.08% Cr; 0.57% Mn; 0.30% V; 0.26% Si; 0.15% C b) 1.53% Cr; 0.72% W; 0.42% Si; 0.4% V; 0.27% Mn; 0.09% C c) 1.55% Cr; 0.31% V; 0.27% Mn; 0.21% Si; 0.08% C d) 1.62% Cr; 0.44% Si; 0.35% V; 0.25% Mn; 0.1% Ti; 0.09% C	Quartz tube differential dilatometer with induction transducer	Points shown are mean values with max. deviation of 3%. Auth. est. accuracy 1.5%. Sample "a" tested after working and heat treating. Tested at 120°C/hr heating rate
◇	Kuz'menko, P. P.	55-81	528-1938	8.25% Cr; 0.09% Si; 0.07% Mn; 0.05% C	X-ray diffraction	Sample annealed 73 hr. at 1200°C

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
▽	Oliver, D. A., and Harris, M. A.	52-25	672-1932	Jessop No. 40 Steel (Brit. Desig.) 2.7% Cr; 0.75% V; 0.5% ea. Mo, W; 0.45% Si; 0.30% ea. Ni, Mn; 0.23% C	Not given	
○	Colbeck, E. W., and Rait, J. R.	52-26	672-1932	H.G.T. 3 Steel (Brit. Desig.) 2.87% Cr; 0.77% V; 0.59% W; 0.51% Mo; 0.45% Si; 0.35% Ni; 0.33% Mn; 0.23% C	Not given	
◠	Cornelius, H.	43-17	528-1752	2.58% Cr; 2.54% Ni; 0.77% Mn; 0.34% Si; 0.09% C; 0.014% P; 0.011% S	Bollenrath type comparative dilatometer	Tested in vacuum at 1.5°C/min. rise
△	Ibid.	43-17	528-1752	5.01% Cr; 0.60% Mn; 0.30% Si; 0.05% C; 0.016% S; 0.015% P	Same as above	Same as above
◡	Perry, S.	45 6	360-528	Stainless steel type 501; nominal: 94-96% Fe; 4-6% Cr; > 0.10% C	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%

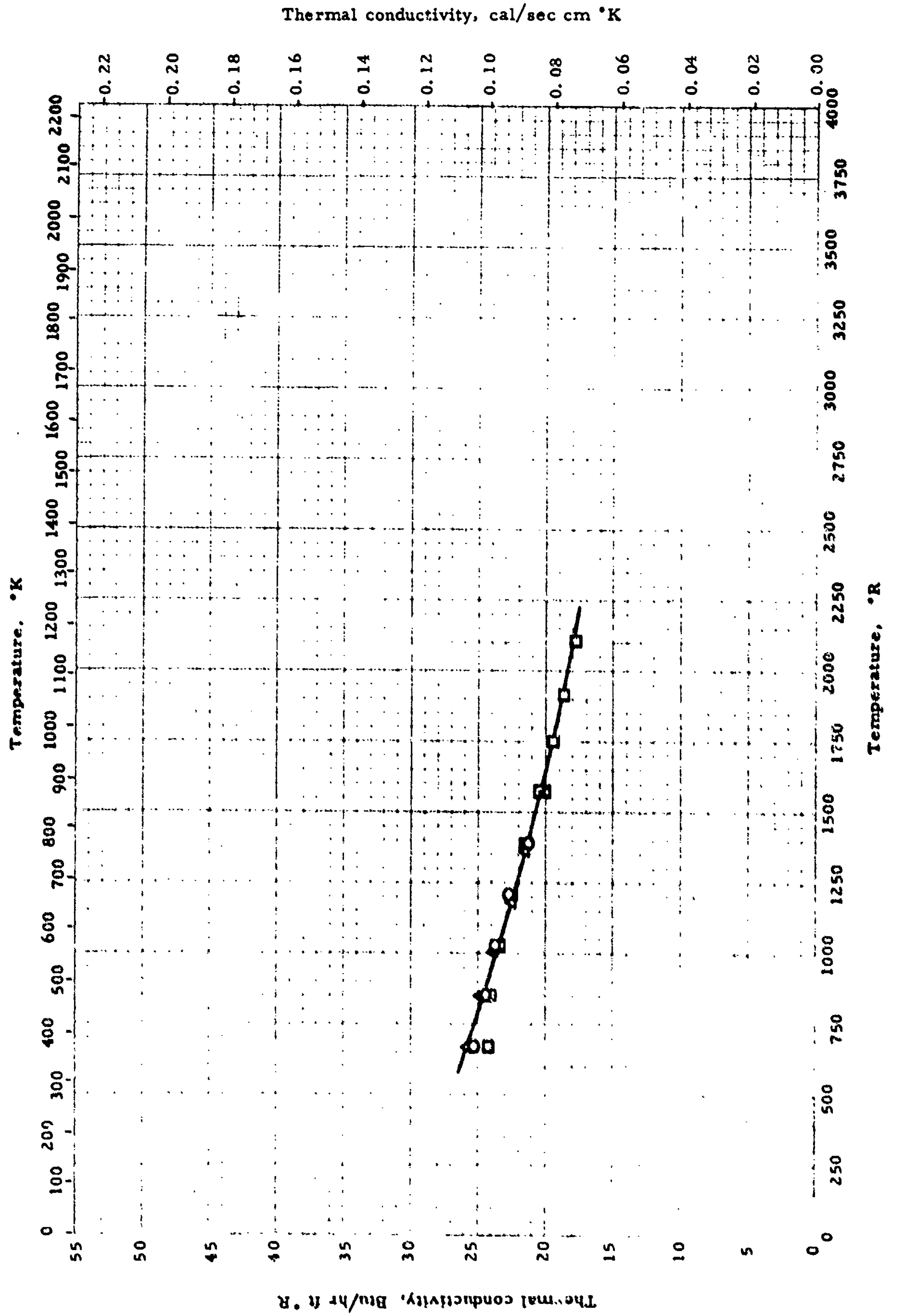


ELECTRIC RESISTIVITY -- IRON + CHROMIUM + X

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
□	Blanter, M. E.	47-13	528-2427	2.09% Cr; 0.58% C; in form of (Fe, Cr)$_3$ C	Potential drop	Auth. est. accuracy ± 2%. Annealed to granular pearlite structure before test. Tested at 20°C/min. above 500°C
△	Ibid.	47-13	528-2247	2.21% Cr; 1.05% C, in form of (Fe, Cr)$_3$C	Same as above	Same as above
○	Ibid.	47-13	528-2382	2.02% Cr; 1.41% C; in form of (Fe, Cr)$_3$C	Same as above	Same as above
○	Ibid.	47-13	528-2337	5.85% Cr. 0.62% C; in form of (Cr, Fe)$_7$C$_3$	Same as above	Same as above
▽	Ibid.	47-13	528-2427	5.89% Cr; 0.96% C, in form of (Cr, Fe)$_7$C$_3$	Same as above	Same as above
◯	Ibid.	47-13	528-2292	5.82% Cr; 1.25% C	Same as above	Same as above
◠	Neimark, B. E.	55-68	672-1792	1.08% Cr; 0.57% Mn; 0.30% V; 0.26% Si; 0.15% C	Potential drop	Average of two samples, one after working, one heat treated. Max. deviation 1.3%
◡	Thomas, H.	50-31	528-1932	3.7% Cr	Self registering photographic device	Values from author's smoothed curve
◡	Ibid.	50-31	528-1932	5.6% Cr	Same as above	Same as above
◺	Ibid.	50-31	528-1932	7.5% Cr	Same as above	Same as above
◇	Ibid.	50-31	528-1932	9.4% Cr	Same as above	Same as above
◻	Powell, R. W. and Tye, R. P.	56-121 also 56-124	528-1480	Type En 19 Steel (British desig.) 1.15% Cr; 0.59% Mn; 0.42% C; 0.33% Ni; 0.23% Si; 0.22% Mo; 0.046% P; 0.019% S	Potential drop	Oil quenched, annealed 1 hr. at 850 °C, cooled slowly, reheated to 650°C for 120 hr., cooled slowly
▷	Ibid.	56-121 also 56-124	490-2110	Type En 31 Steel (British desig.) 1.5% Cr; 1.05% C; 0.73% Mn; 0.23% ea. Ni, Si; 0.21% Mo; 0.030% P; 0.028% S	Same as above	Oil quenched from 830°C, tempered 2 hr. at 750°C
◇	Colbeck, E. W. and Rait, J. R.	52-26	528-1752	H. G. T. 3 steel (British desig.) 2.87% Cr; 0.77% V; 0.59% W; 0.51% Mo; 0.45% Si; 0.35% Ni; 0.33% Mn; 0.23% C	Not given	

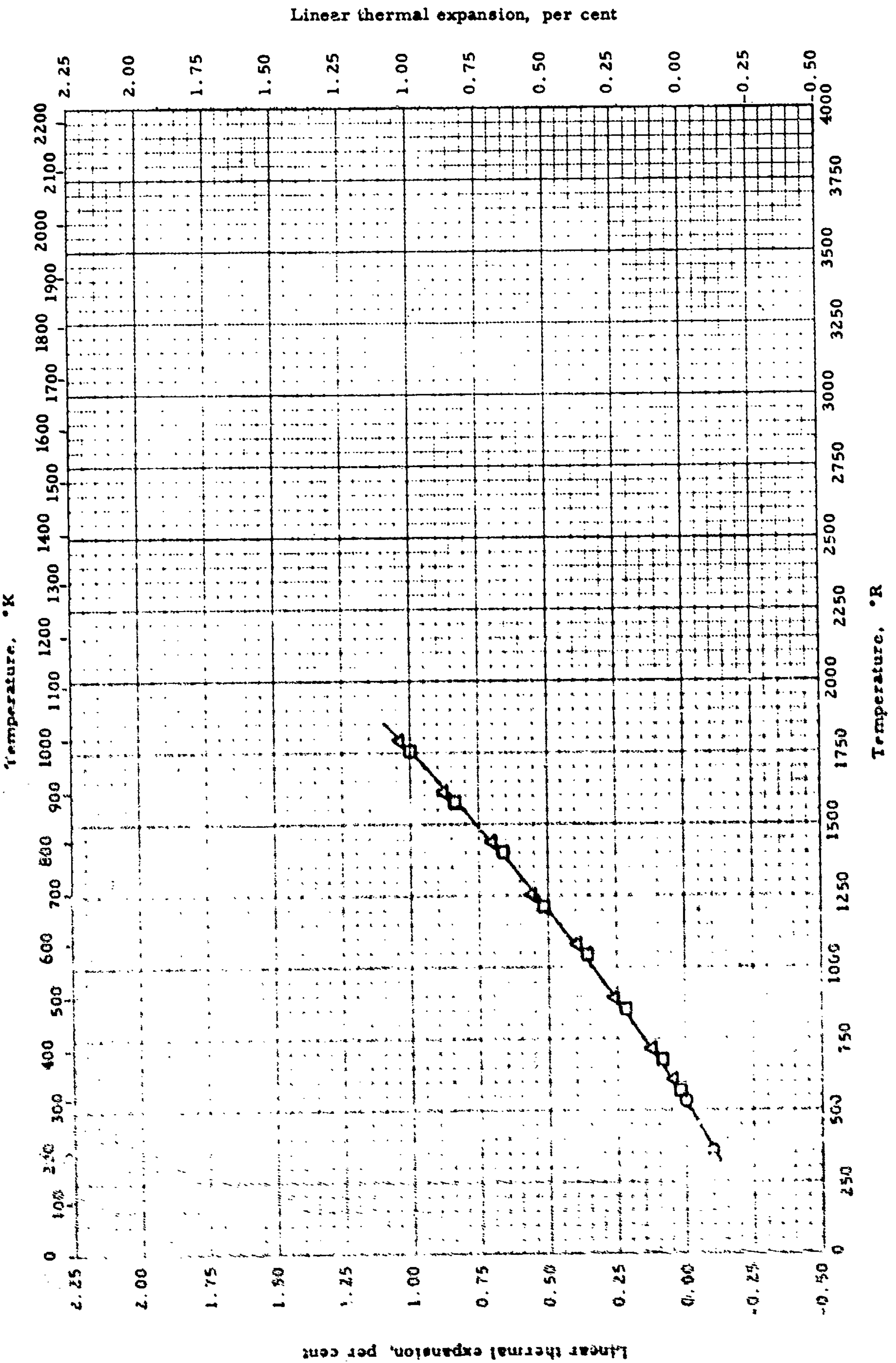


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + MOLYBDENUM + X

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Neimark, B. E.	55-68	672-2112	0.34% Mn; 0.52% Cr; 0.50% Mo; 0.28% Si; 0.15% C	Temp. distribution along resistance heated rod	Initial condition
□	Ibid.	55-68	672-2112	Same as above	Same as above	Normalized
△	Ibid.	55-68	672-2112	Same as above	Same as above	Annealed

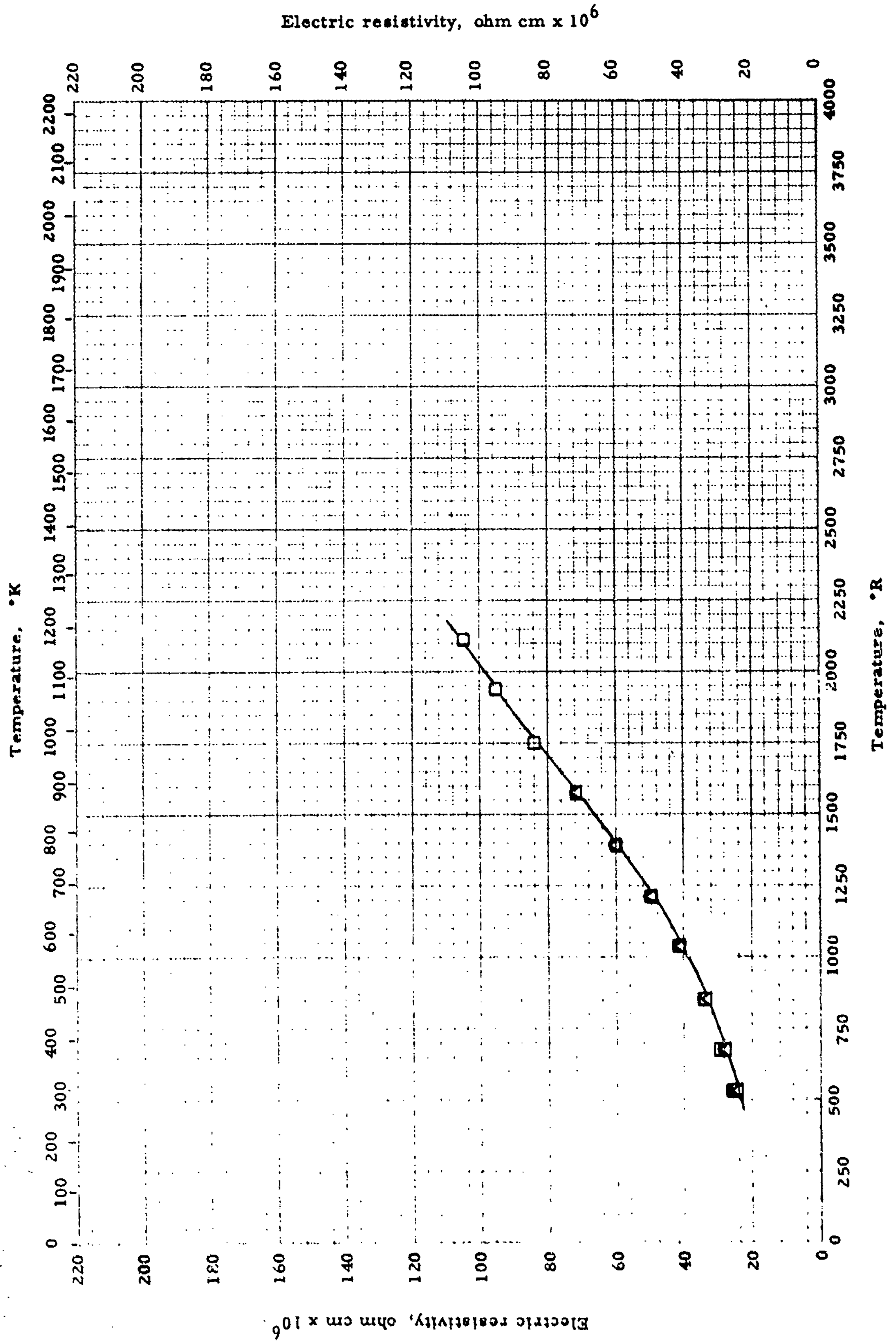


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + MOLYBDENUM + X

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Perry, S.	45-6	360-528	S. A. E. 4130; nominal: 97.8% Fe; 0.87% Cr; 0.51% Mn; 0.39% C; 0.20% Mo; 0.19% Si; 0.029% S; 0.015% P	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
□	[illegible], B. E.	55-68	528-1752	0.54% Mn; 0.52% Cr, 0.50% Mo; 0.28% Si, 0.15% C	Quartz tube dilatometer	Average of four samples (1) as received, (2) normalized, (3) annealed, (4) spheroidized. All results within ± 1.5%. Tested at 2°C/min. rise. Auth. est. accuracy of each ± 1-1.5%
△	[illegible]	55-68	528-1752	0.55% Cr; 0.55% V, 0.32% Mn; 0.22% Si; 0.18% Mo; 0.08% C	Same as above	Tested at 2°C/min. rise. Auth. est. accuracy ± 1-1.5%

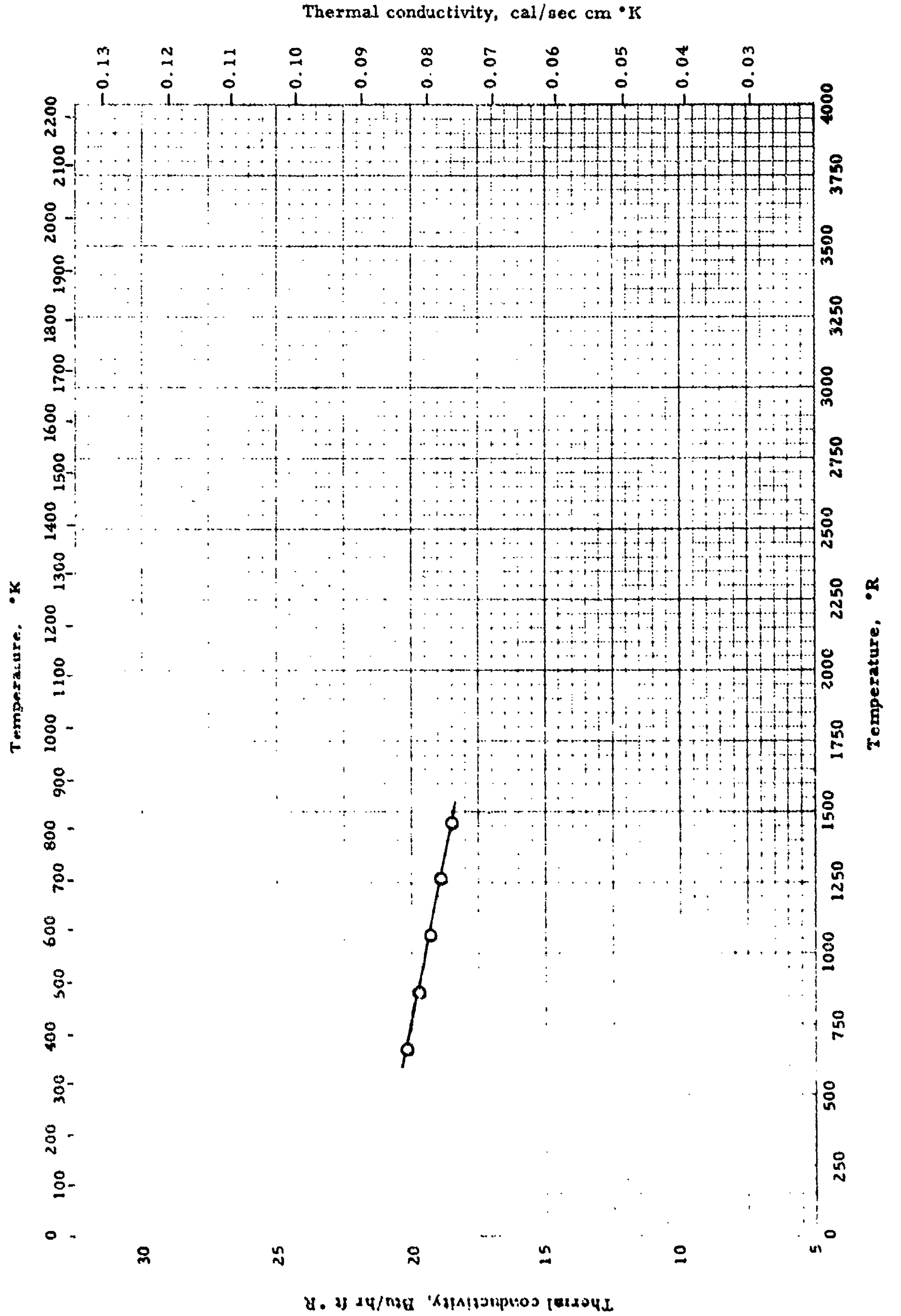


ELECTRIC RESISTIVITY -- IRON + CHROMIUM + MOLYBDENUM + X

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

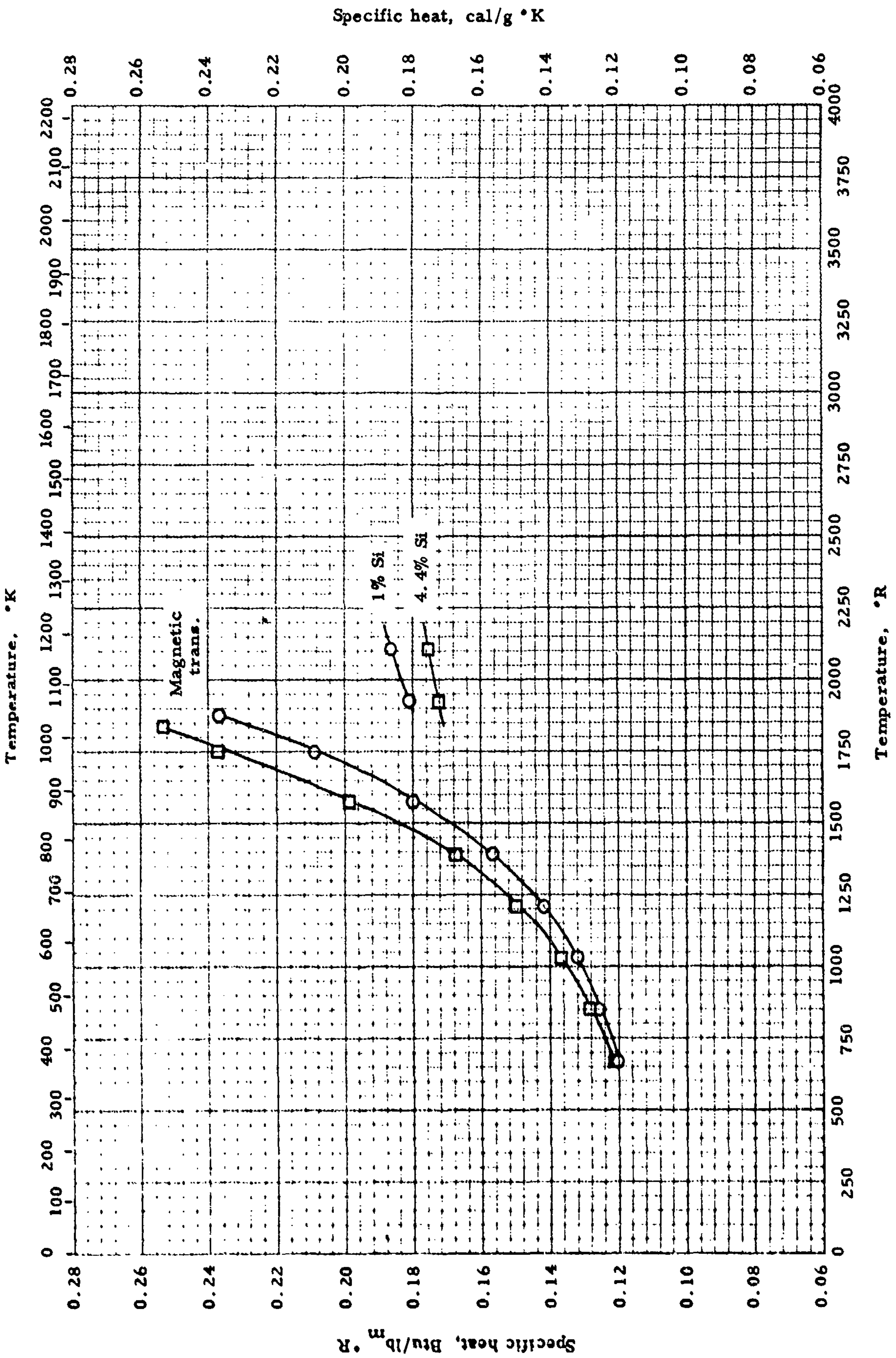
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Neimark, B.E.	55-68	528-2112	0.54% Mn; 0.[illegible] Cr; 0.50% Mo; 0.28% Si; 0.[illegible]5% C	Potential drop	Initial condition
□	Ibid.	55-68	528-2112	Same as above	Same as above	Normalized
△	Ibid.	55-68	528-2112	Same as above	Same as above	Annealed



THERMAL CONDUCTIVITY -- IRON + TUNGSTEN + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Loewen, E. G.	56-21	660-1460	High speed steel (M-2); 83% Fe; 6% W; 5% Mo; 4% Cr; 2% V	Axial heat flow in rod; calorimeter sink; guarded sample	Annealed

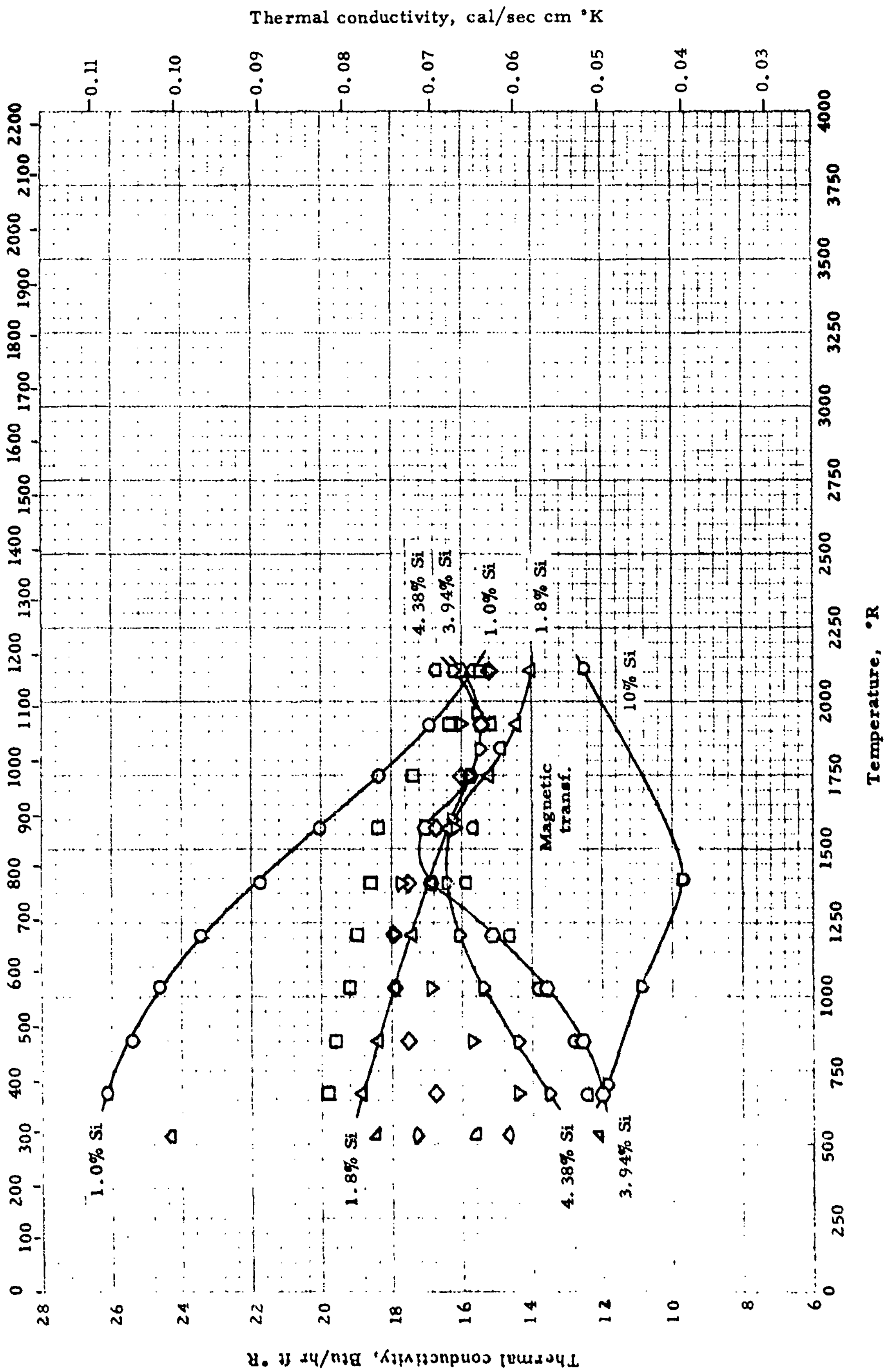


SPECIFIC HEAT -- IRON + SILICON + X

SPECIFIC HEAT -- IRON + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gel'd, P.V., Kuprovskii, B.B., and Serebrennikov, N.N.	56-36	672-2112	1% Si; 0.07% C; 0.026% S; 0.025% Mn; 0.024% P	Drop method, liquid calorimeter	Sample soaked isothermally in furnace for 1 hr. prior to drop
□	Ibid.	56-36	672-2112	4.38% Si; 0.20% Mn; 0.07% C; 0.05% Al; 0.015% P; 0.008% S	Same as above	Same as above; values for intermediate compositions can be interpolated

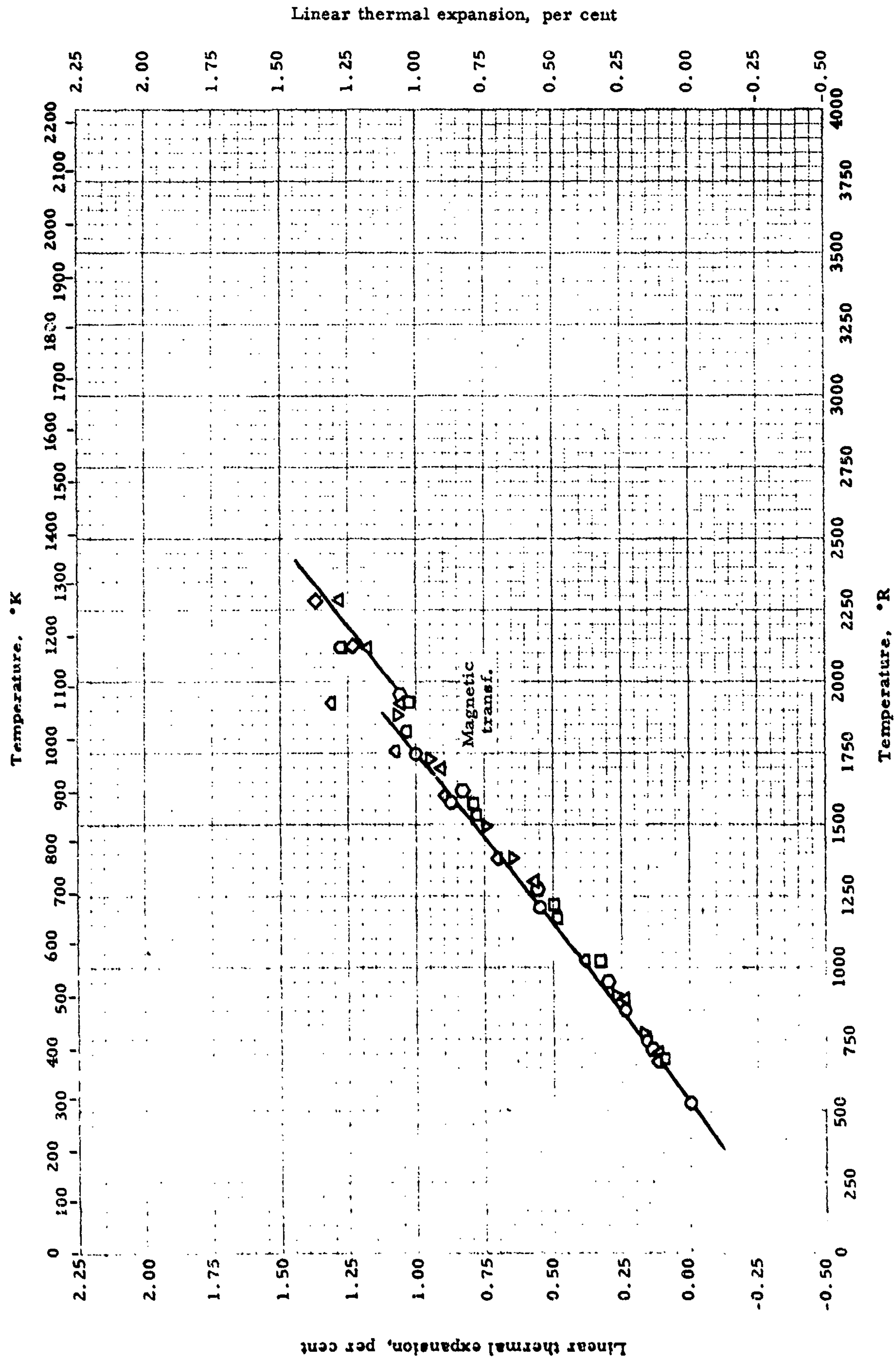


THERMAL CONDUCTIVITY -- IRON + SILICON + X

THERMAL CONDUCTIVITY -- IRON + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gel'd, P. V., Kuprovskii, B. B., and Serebrennikov, N. N.	56-36 also 56-106	672-2112	1% Si; 0.25% Mn, 0.07% C; 0.026% S; 0.024% P	Radial heat flow in stack of cylindrical disks	Soaked at each temp. level at least 2 hr.
□	Ibid.	56-36	672-2112	1.23% Si; 0.29% Mn, 0.09% C; 0.047% P; 0.029% S; 0.01% Al	Same as above	Same as above
△	Ibid.	56-36	672-2112	1.80% Si; 0.32% Mn; 0.09% C; 0.038% P; 0.023% S; 0.01% Al	Same as above	Same as above
◇	Ibid.	56-36	672-2112	2.20% Si; % of C, Mn, P, S, and Al not given	Same as above	Same as above
▽	Ibid.	56-36	672-2112	2.78% Si; 0.35% Mn; 0.09% C; 0.06% Al; 0.034% P; 0.023% S	Same as above	Same as above
○	Ibid.	56-36	672-2112	3.94% Si; 0.27% Mn, 0.09% Al; 0.08% C; 0.027% P; 0.008% S	Same as above	Same as above
○	Ibid.	56-36	672-2112	4.28% Si; 0.08% Mn; 0.06% C; 0.05% Al; 0.012% P; 0.006% S	Same as above	Same as above
○	Ibid.	56-36	672-2112	4.38% Si, 0.20% Mn, 0.07% C, 0.05% Al; 0.015% P; 0.008% S	Same as above	Same as above
○	Kuprovsky, B. B. and Gel'd, P. V.	56-106	672-2112	10% Si	Radial heat flow in thick-walled cylinder	Auth. est. accuracy ± 7%
○	Glaser, F. W. and Ivanick, W.	56-122	Room	2.5% Si	"Heating one end and cooling other". Temp. meas. by platinum-platinum-rhodium thermocouples	Mixed from powders, cold or hot pressed, homogenized 6-12 hr. at 1150 °C. Identical results for both "ordered" and "disordered" alloys
△	Ibid.	56-122	Room	5.0% Si	Same as above	Same as above
◇	Ibid.	56-122	Room	7.5% Si	Same as above	Mixed from powders, cold or hot pressed, homogenized 6-12 hr. at 1150 °C. "Ordered" alloy
○	Ibid.	56-122	Room	Same as above	Same as above	Mixed from powders, cold or hot pressed, homogenized 6-12 hr. at 1150 °C. "Disordered" alloy
□	Ibid.	56-122	Room	10.0% Si	Same as above	Mixed from powders, cold or hot pressed, homogenized 6-12 hr. at 1150 °C. "Ordered" alloy
△	Ibid.	56-122	Room	Same as above	Same as above	Mixed from powders, cold or hot pressed, homogenized 6-12 hr. at 1150 °C. "Disordered" alloy

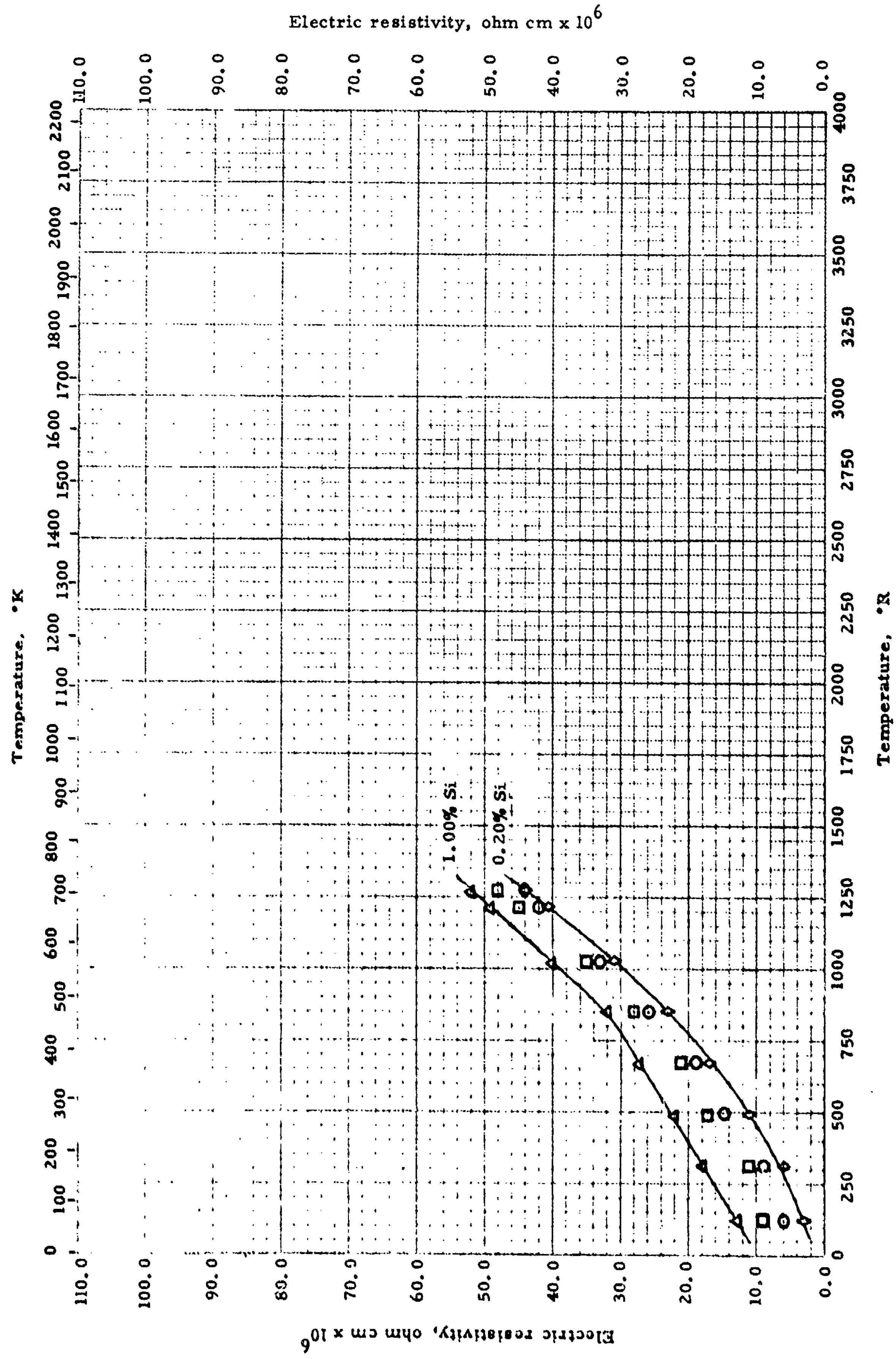


LINEAR THERMAL EXPANSION -- IRON + SILICON + X

LINEAR THERMAL EXPANSION -- IRON + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H.	43-17	528-2112	6 samples: a) 2.0-2.4% Mn; 0.30-0.60% Si; 0.12-0.20% C; 0.02% P; 0.02% S b) 2.08% Mn; 0.52% Si; 0.64% Al; 0.34% C; 0.24% V c) 1.81% Mn; 0.71% Si; 0.31% C; 0.26% V d) 1.22% Mn; 1.13% Si; 0.33% C; 0.027% S; 0.020% P e) 1.78% Mn; 1.17% Si; 0.91% Cr; 0.33% C; 0.23% Ti f) 1.77% Mn; 1.18% Si; 0.96% Th; 0.30% C	Boilenrath dilatometer	Points shown are mean values with max. deviation of 3%. Heating rate 1.5°C/min.
□	Gel'd, V., Serebrennikov, N.N. and Sukharev, P.M.	56-39 56-36	672-1932	1.00% Si; 0.25% Mn; 0.11% Cu; 0.07% C; 0.03% Al; 0.026% S; 0.024% P	Differential dilatometer, photo recording	Annealed
△	Ibid.	56-39 56-36	672-2292	2.20% Si; 0.17% Mn; 0.13% Cu; 0.07% ea.C, Al; 0.023% P; 0.011% S	Same as above	Same as above
◇	Ibid.	56-39 56-36	672-2292	2.78% Si; 0.12% Mn; 0.12% Cu; 0.08% Al; 0.07% C; 0.020% P; 0.010% S	Same as above	Same as above
▽	Ibid.	56-39 56-36	852-1932	3 samples: a) 3.98% Si; 0.23% Mn; 0.19% Cu; 0.09% Al; 0.06% C; 0.019% P; 0.011% S b) 4.07% Si c) 4.38% Si; 0.20% Mn; 0.07% C; 0.015% P; 0.008% S	Same as above	Same as above. Average for 3 samples within 4%
○	Ibid.	56-39 56-36	672-1932	5.11% Si	Same as above	Same as above
◠	Ibid.	56-39 56-36	672-2112	6.01% Si	Same as above	Same as above
◠	Ibid.	56-39 56-36	672-1952	8.13% Si	Same as above	Same as above



ELECTRIC RESISTIVITY - - IRON + SILICON

ELECTRIC RESISTIVITY -- IRON + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
◊	Domenicali, C.A.; and Otter, F.A.	55-7	132-1266	0.20% Si	Potential drop	Alloy prepared from 99.95% pure Fe and 99.95% pure Si. Homogenized for 6-10 hr. just below M.P.
○	Ibid.	55-7	132-1266	0.40% Si	Same as above	Same as above
□	Ibid.	55-7	132-1266	0.60% Si	Same as above	Same as above
△	Ibid.	55-7	132-1266	1.00% Si	Same as above	Same as above

PROPERTIES OF LOW ALLOY STEEL
(Sintered Porous Steel)

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 97% Fe	450 lb_m/ft^3	7.23 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	○	451	7.23
	□	408	6.53
	△	395	6.32

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

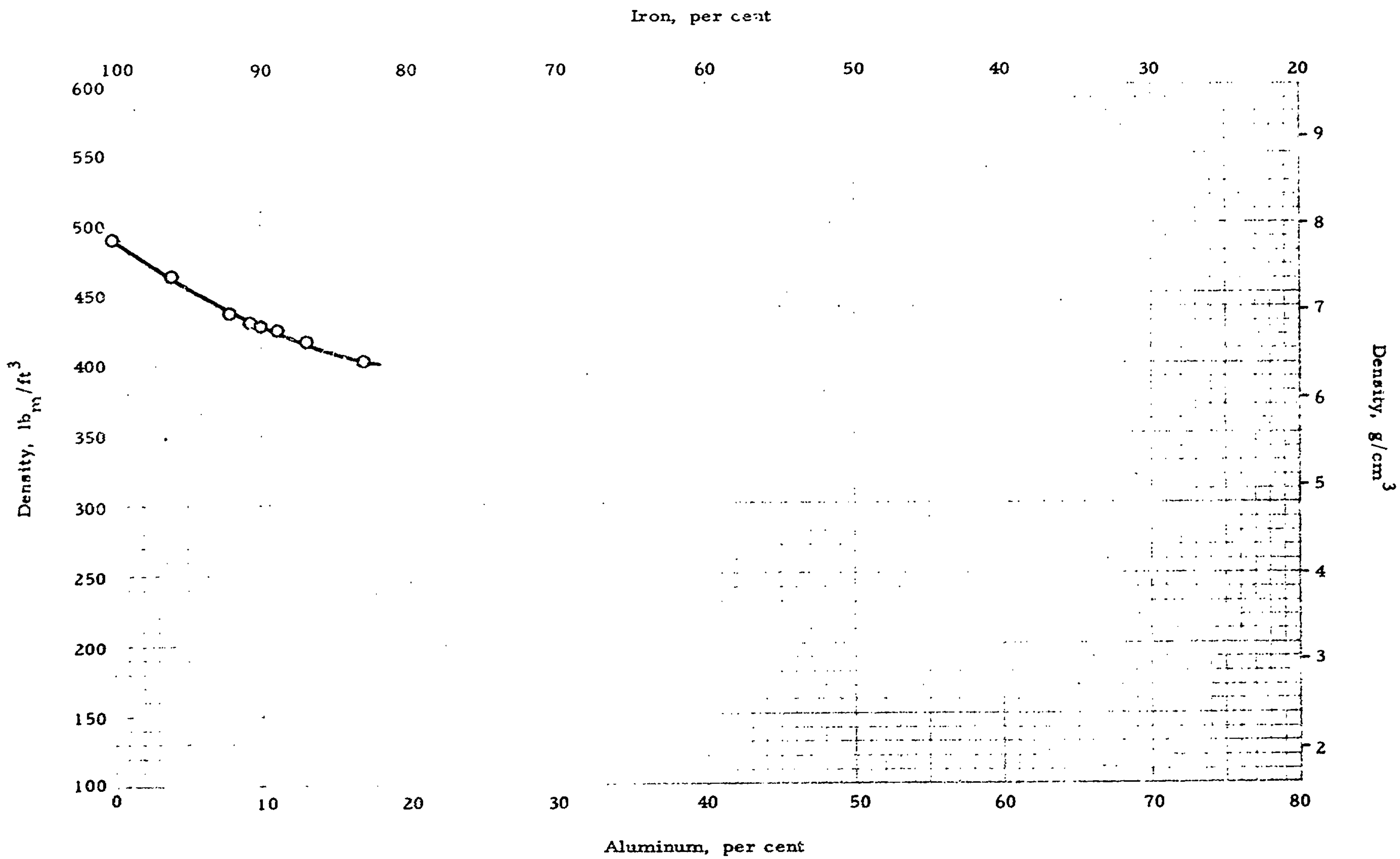
Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF LOW ALLOY STEEL
(Sintered Porous Steel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mirrynkov, V. E. and Pozdnyak, N. Z.	53-103	Room	96.64% Fe; 1.5% Fe_2O_3; 0.65% FeO; 0.60% Si; 0.35% Mn; 0.06% C	ρ: not given	Prepared from powder; pressed in 110 ton press, heated in H_2 atm. in steps to 600, 800, 1000 and 1150°C, furnace cooled to 800°C, then in H_2 stream to room temp. Auth. report theor. zero-porosity density as 7.62 g/cm^3
◻	Ibid.	53-103	Room	96.553% Fe; 1.9% Fe_2O_3; 0.70% Si; 0.4% FeO; 0.35% Mn; 0.097% C	ρ: same as above	Same as above
△	Ibid.	53-103	Room	96.473% Fe; 1.9% Fe_2O_3; 0.6% FeO; 0.59% Si; 0.35% Mn; 0.087% C	ρ: same as above	Same as above

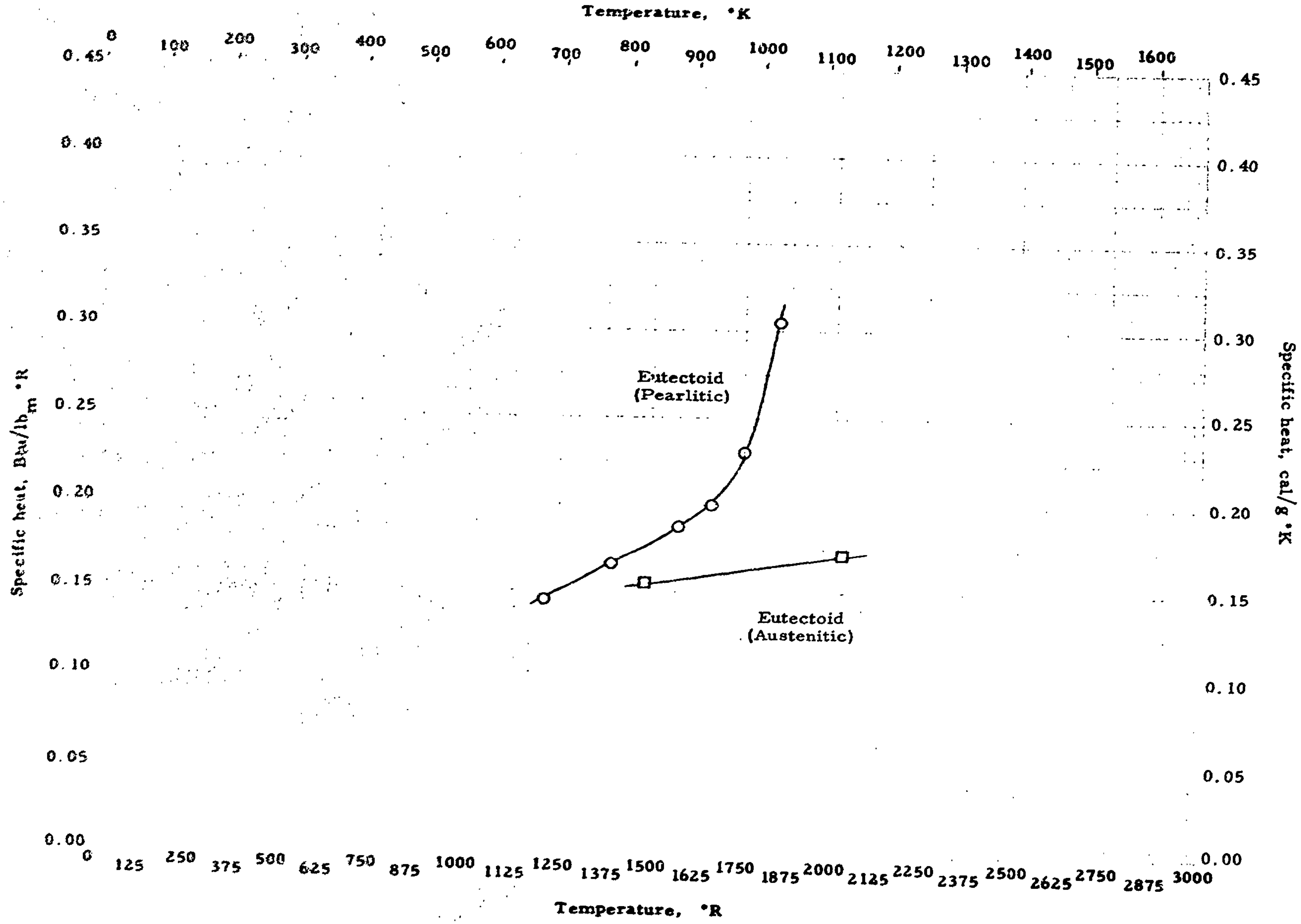


DENSITY -- IRON + ALUMINUM

DENSITY -- IRON + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Masumoto, H. and Saito, H.	51-70	Room	0 - 17% Al	Weight in air and in water	Made from electrolytic Fe and Al. Forged, machined, annealed 1 hr at 1000° C; furnace cooled to 700° C, then cooled to room temperature at 30°/hr

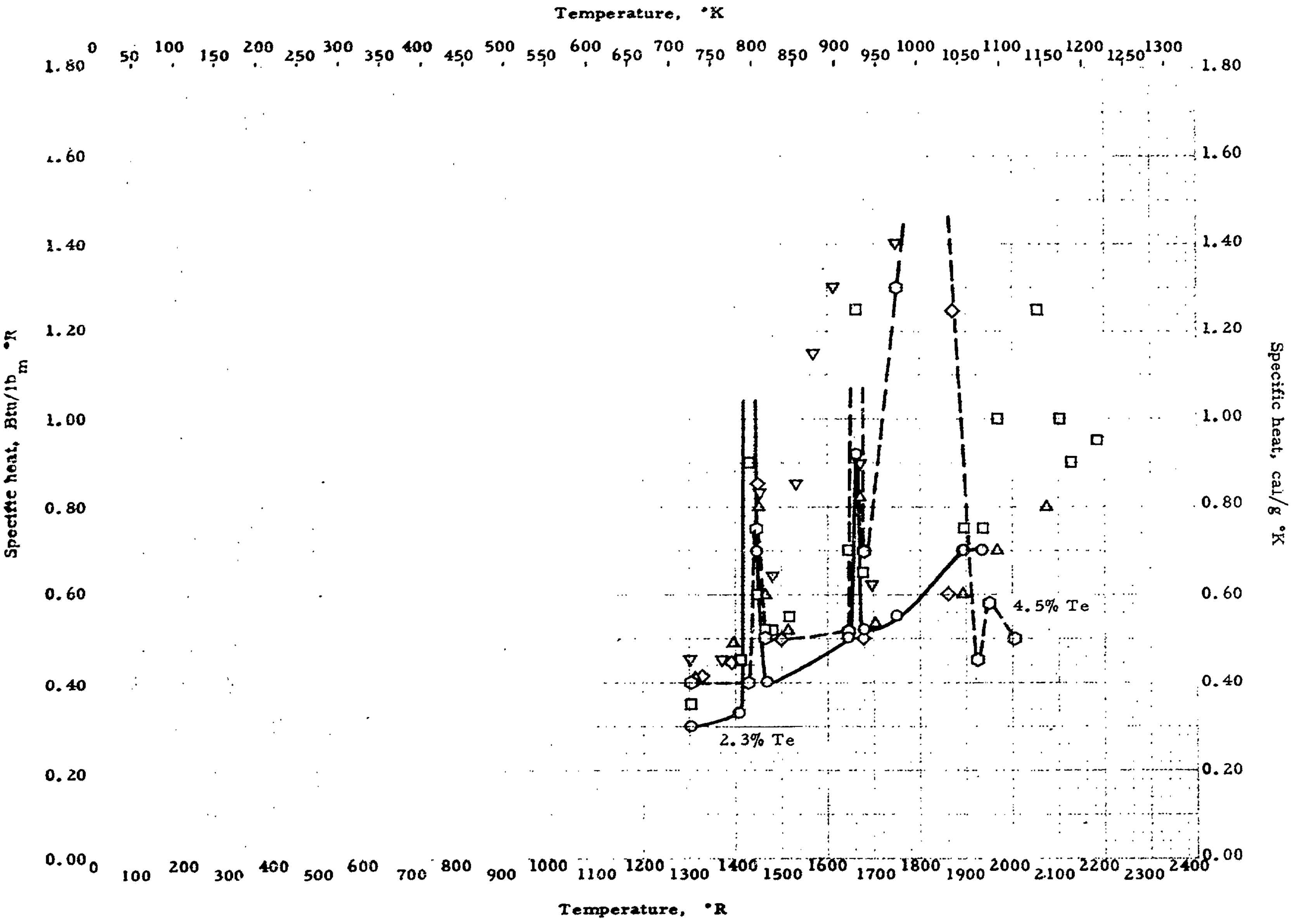


SPECIFIC HEAT -- IRON + COBALT + X

SPECIFIC HEAT -- IRON + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hagel, W. C., Pound, G. M., and Mehl, R. F.	54-9	1212-1842	Eutectoid Steel Alloy; 1.91% Co; 0.79% C; 0.22% Si; 0.12% Mn; 0.014% S; 0.005% P; Pearlitic	Comparative; rate of temp. rise in sample compared with standard under same heating condition	
□	Ibid.	54-9	1482-2022	Same compos. as above, Austentic	Same as above	

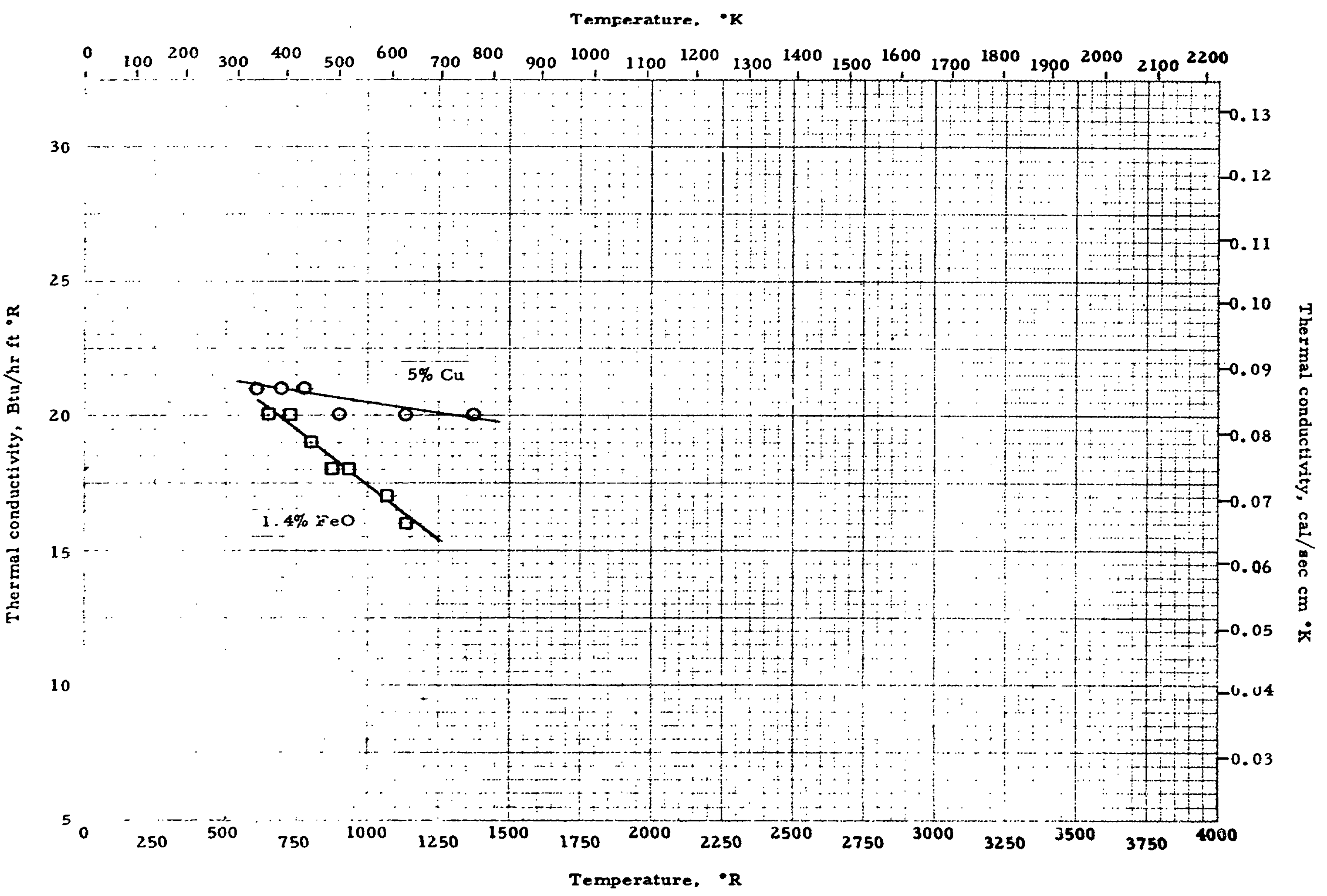


SPECIFIC HEAT -- IRON + TELLURIUM

SPECIFIC HEAT -- IRON + TELLURIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Chiba, S.	55-116	1302-1937	2.26% Te	Thermal analysis	Made from double distilled Te and 99.98% pure electrolytic Fe.
□	Ibid.	55-116	1302-2184	2.43% Te	Same as above	Same as above
△	Ibid.	55-116	1302-2076	2.99% Te	Same as above	Same as above
◇	Ibid.	55-116	1302-1869	3.45% Te	Same as above	Same as above
▽	Ibid.	55-116	1302-1752	4.02% Te	Same as above	Same as above
⬡	Ibid.	55-116	1302-2004	4.46% Te	Same as above	Same as above

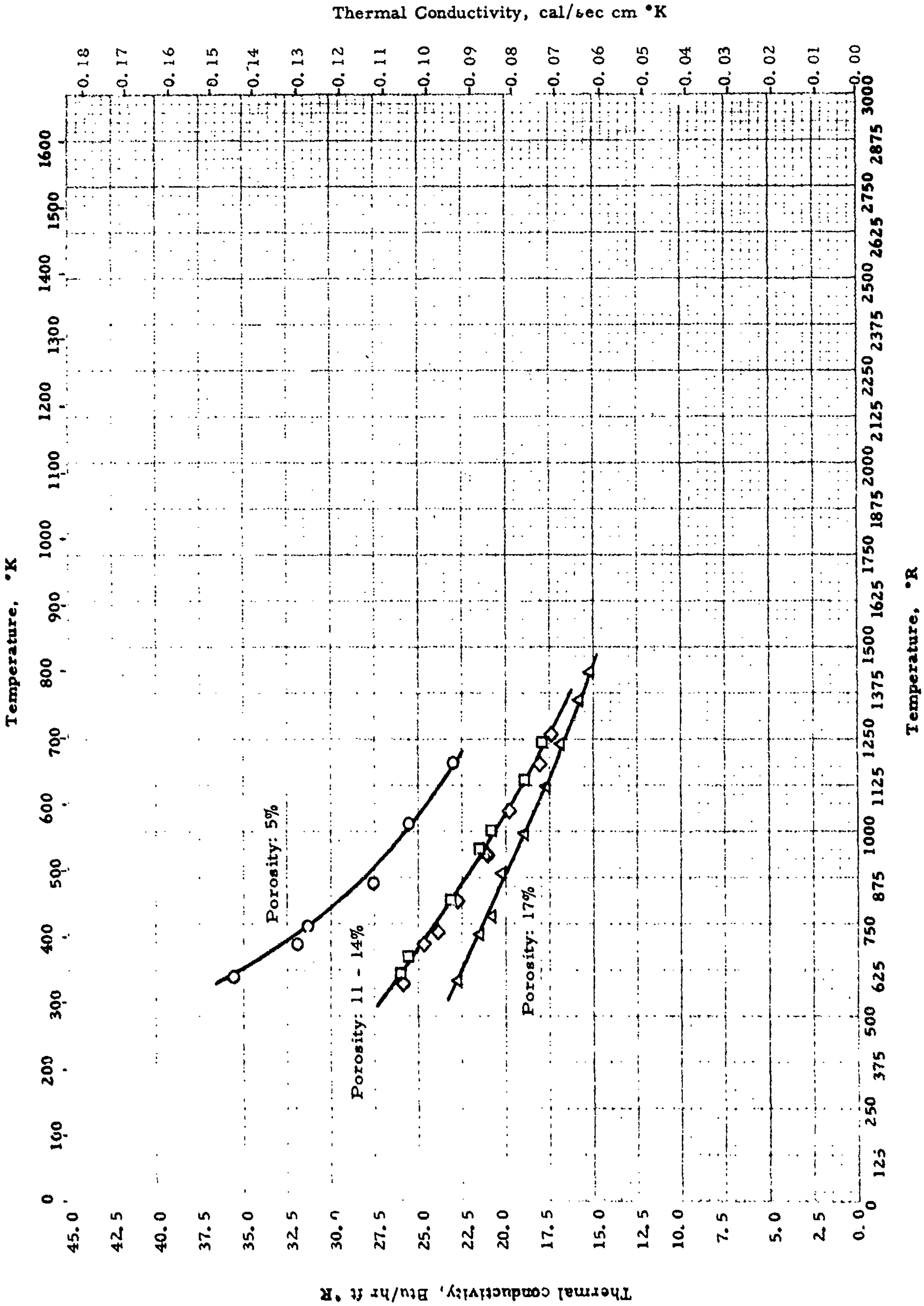


THERMAL CONDUCTIVITY -- POROUS IRON + GRAPHITE ANTI-FRICTION ALLOYS

THERMAL CONDUCTIVITY -- POROUS IRON + GRAPHITE ANTI-FRICTION ALLOYS

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V.E. and Pozdnyak, N. Z.	54-50	600-1374	91.84% Fe; 5.0% Cu; 1.66% C; 0.44% Mn; 0.35% Si; 0.30% (FeO + Fe_2O_3); porosity 17%	Temp. distribution along resistance heated rod	Sintered 1.5 hr. at 1150 °C in H_2 atmos.
□	Ibid.	54-50	654-1140	95.76% Fe; 1.43% FeO; 1.13% C; 0.8% Fe_2O_3; 0.43% Mn; 0.4% Si; porosity 19%	Same as above	Same as above

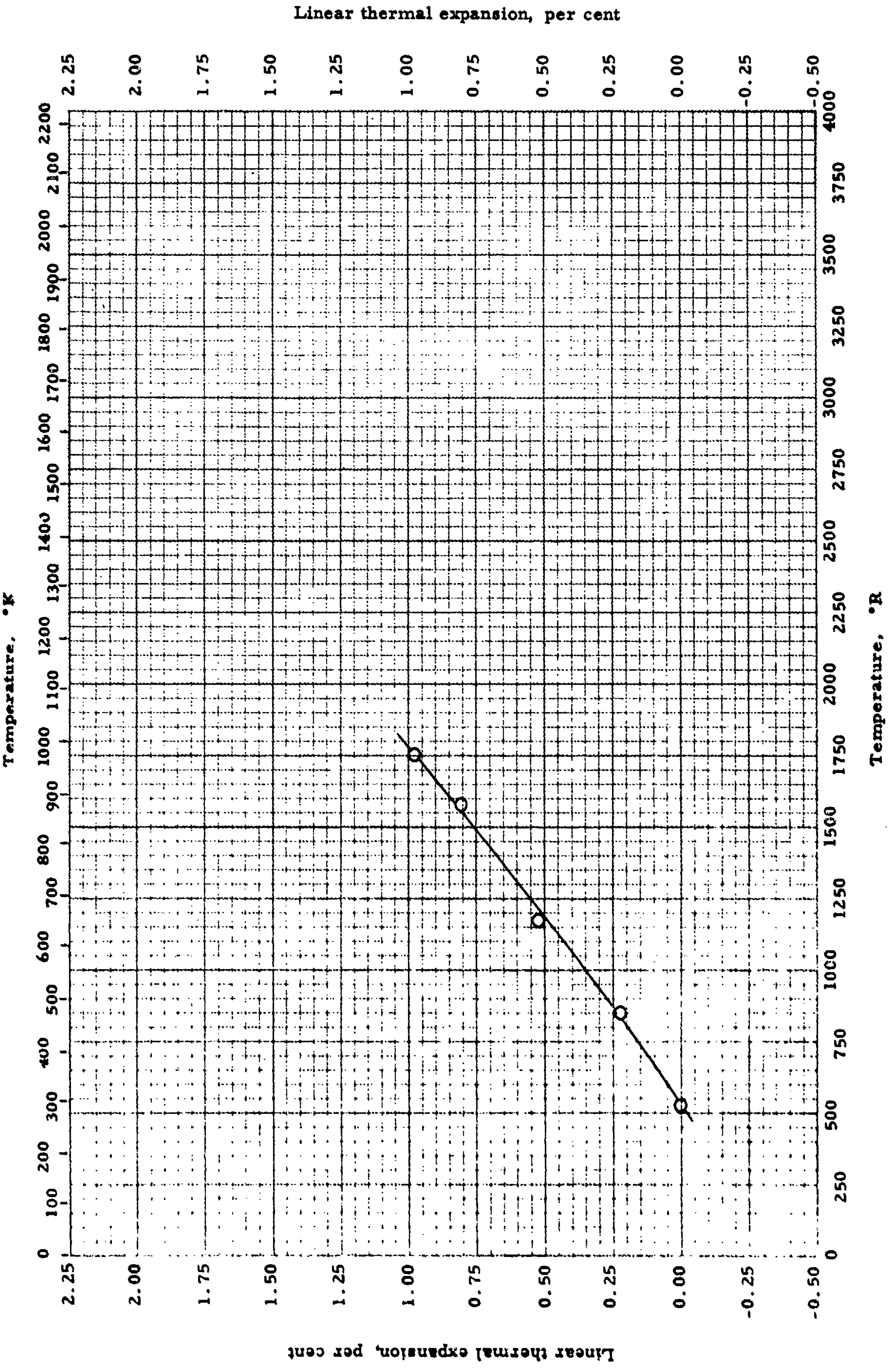


THERMAL CONDUCTIVITY -- SINTERED POROUS IRON-BASE MATERIAL

THERMAL CONDUCTIVITY -- SINTERED POROUS IRON-BASE MATERIAL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E. and Pozdnyak, N. Z.	53-103	604-1190	96.84% Fe; 1.5% Fe_2O_3; 0.65% FeO; 0.60% Si; 0.35% Mn; 0.06% C	Temp. distribution in rod heated at one end	Powder pressed, heated in H_2 to 2560°R; furnace cooled to 1932°R; then in H_2 to room temp. Auth. quote theoretical ρ = 7.62 g/cm³. Auth. est. accuracy $\pm$ 3%. 5.1% porosity
□	Ibid.	53-103	616-1247	96.553% Fe; 1.9% Fe_2O_3; 0.70% Si; 0.4% O; 0.35% Mn; 0.097% C	Same as above	Same as above. 14.3% porosity
△	Ibid.	53-103	590-1432	96.473% Fe; 1.9% Fe_2O_3; 0.6% FeO; 0.59% Si; 0.35% Mn; 0.087% C	Same as above	Same as above. 17% porosity
◇	Ibid.	53-103	585-1266	96.45% Fe; 1.8% Fe_2O_3; 0.7% FeO; 0.60% Si; 0.35% Mn; 0.18% C	Same as above	Same as above. 11.4% porosity

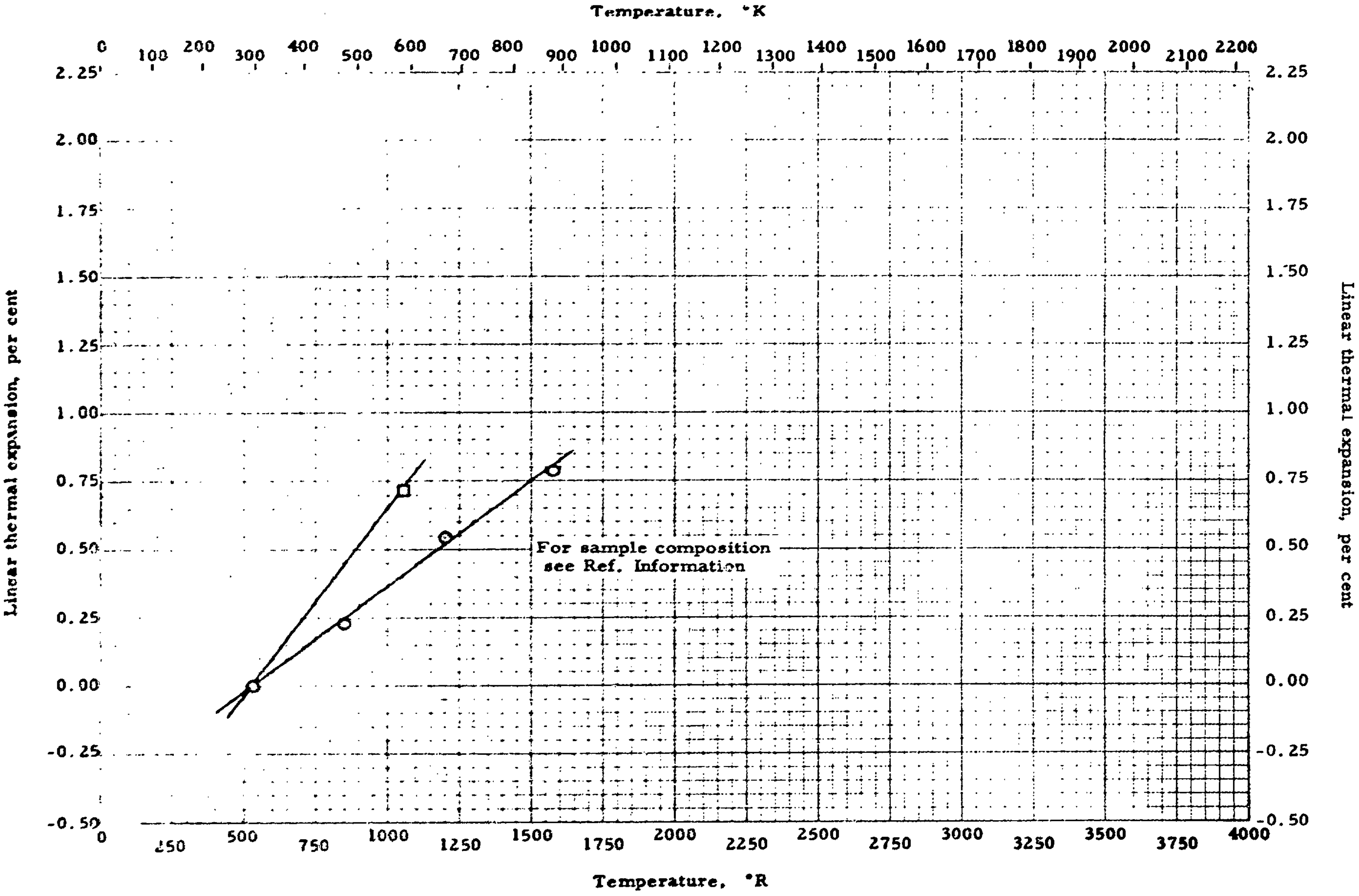


LINEAR THERMAL EXPANSION -- IRON + ALUMINUM + X

LINEAR THERMAL EXPANSION -- IRON + ALUMINUM + X

REFERENCE INFORMATION

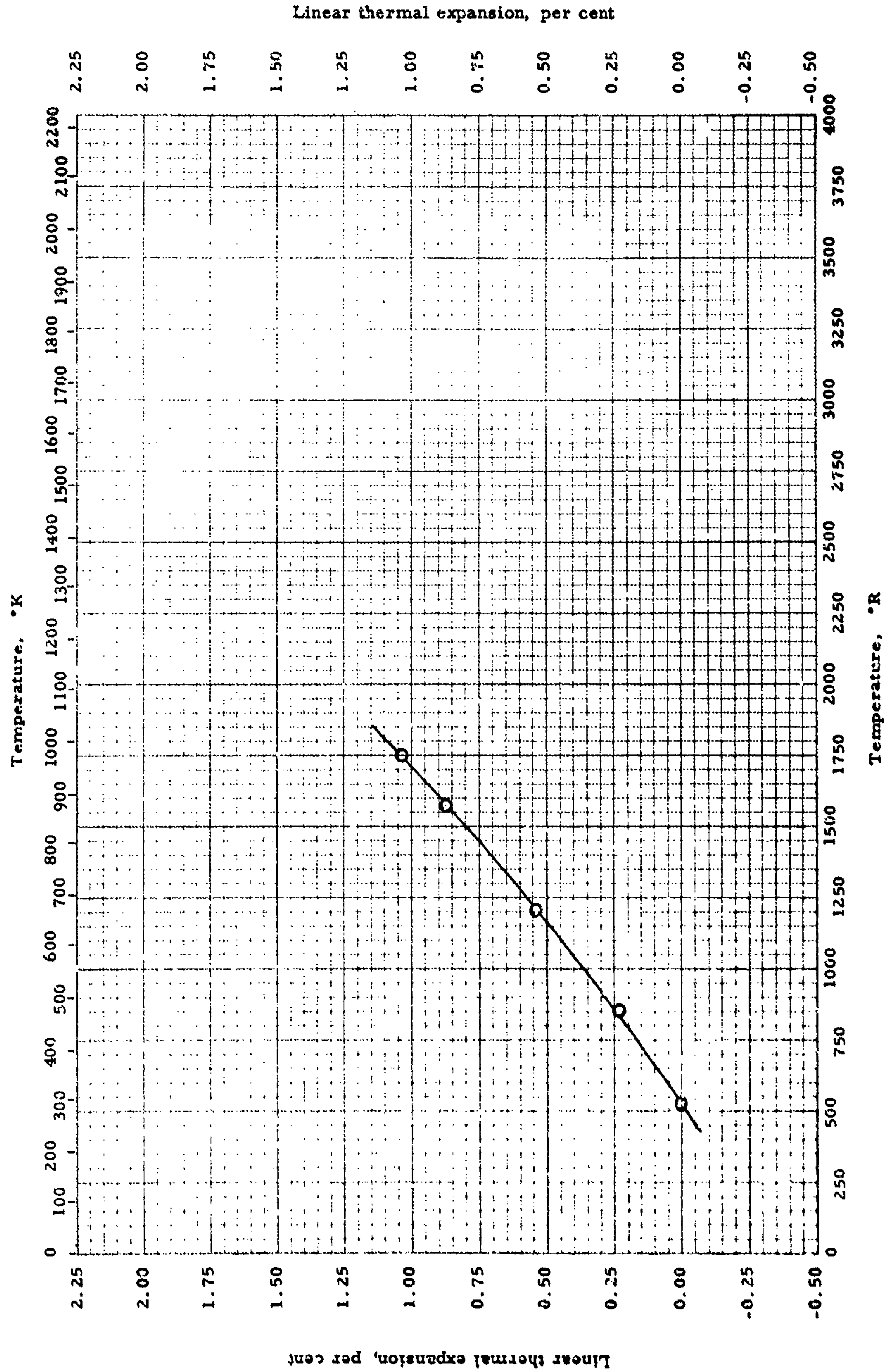
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H.	43-17	528-1752	2.02% Mn; 1.22% Al; 0.86% Si; 0.31% C	Dilatometer	Heating rate 1.5°C/min. in vacuum



LINEAR THERMAL EXPANSION -- IRON + MANCANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H.	43-17	528-2112	3.66% Mn; 0.86% Si; 0.14% C; 0.023% S; 0.012% P	Bollenrath dilatometer	
□	Payson, P.	56-80	530-1060	9.1% Mn; 6.1% Ni; 0.69% C; 0.11% Si	Not given	Air cooled from 2100°F

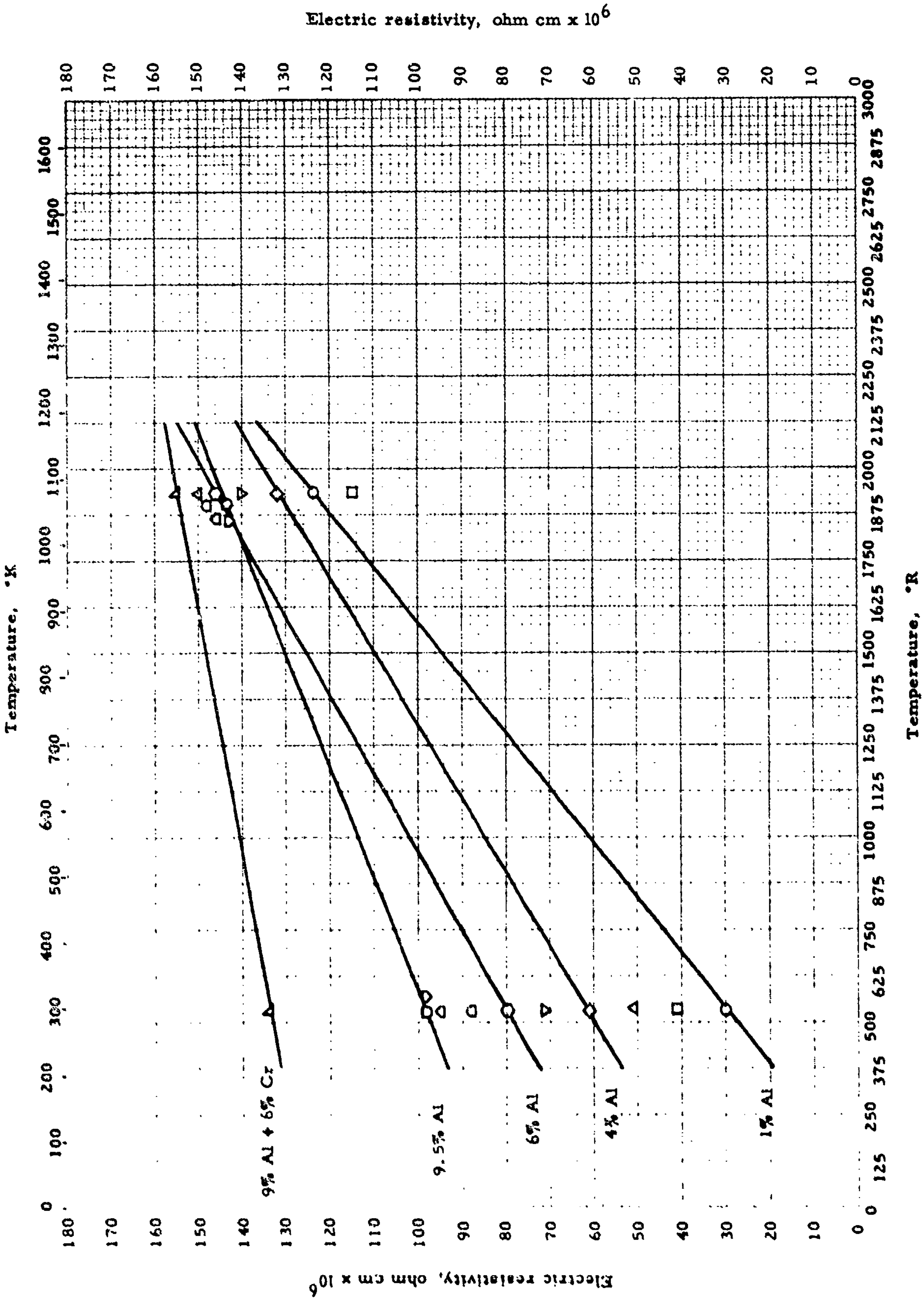


LINEAR THERMAL EXPANSION -- IRON + VANADIUM + X

LINEAR THERMAL EXPANSION -- IRON + VANADIUM + X

REFERENCE INFORMATION

Sym bol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H.	43-17	528-2112	1.69% Mn; 0.41% C; 0.26% Si; 0.15% V; 0.025% S; 0.017% P	Bollenrath dilatometer	

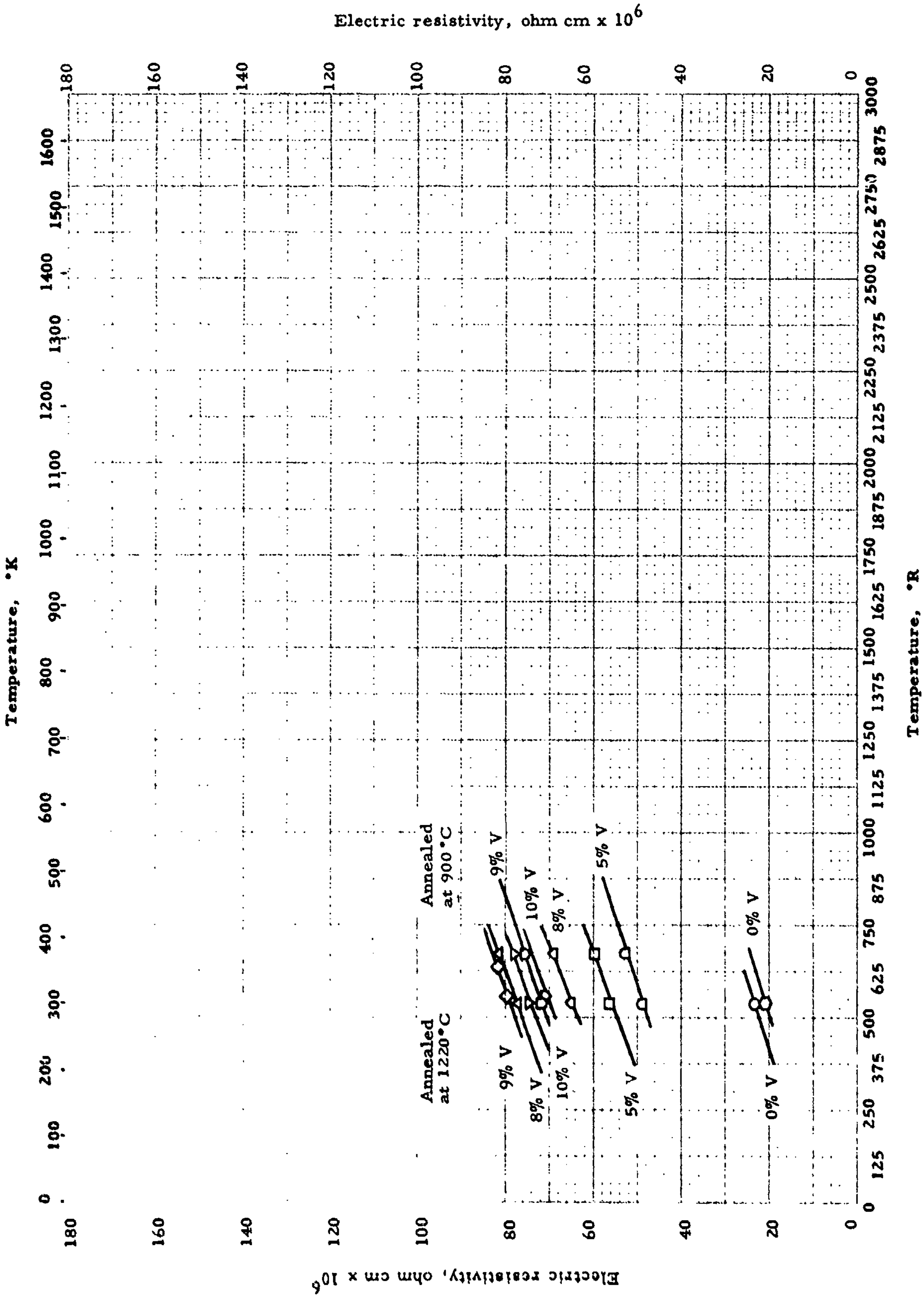


ELECTRIC RESISTIVITY -- IRON + ALUMINUM + X

ELECTRIC RESISTIVITY -- IRON + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Thomas, H.	50-31	528-1932	1.0% Al	Potential drop, thermocouple with automatic plotting	Annealed. Results may not be equilibrium data
□	Ibid	50-31	528-1932	2.0% Al	Same as above	Same as above
△	Ibid	50-31	528-1932	3.0% Al	Same as above	Same as above
◇	Ibid	50-31	528-1932	4.0% Al	Same as above	Same as above
▽	Ibid	50-31	528-1932	5.1% Al	Same as above	Same as above
○	Ibid	50-31	528-1932	6.2% Al	Same as above	Same as above
□	Ibid	50-31	528-1932	7.3% Al	Same as above	Same as above
△	Ibid	50-31	528-1932	8.4% Al	Same as above	Same as above
□	Ibid	50-31	528-1932	9.6% Al	Same as above	Same as above
▽	Ibid	50-31	528-1932	9.4% Al	Same as above	Same as above
△	Ibid	50-31	528-1932	84.8% Fe; 9.1% Al; 6.1% Cr	Same as above	Same as above

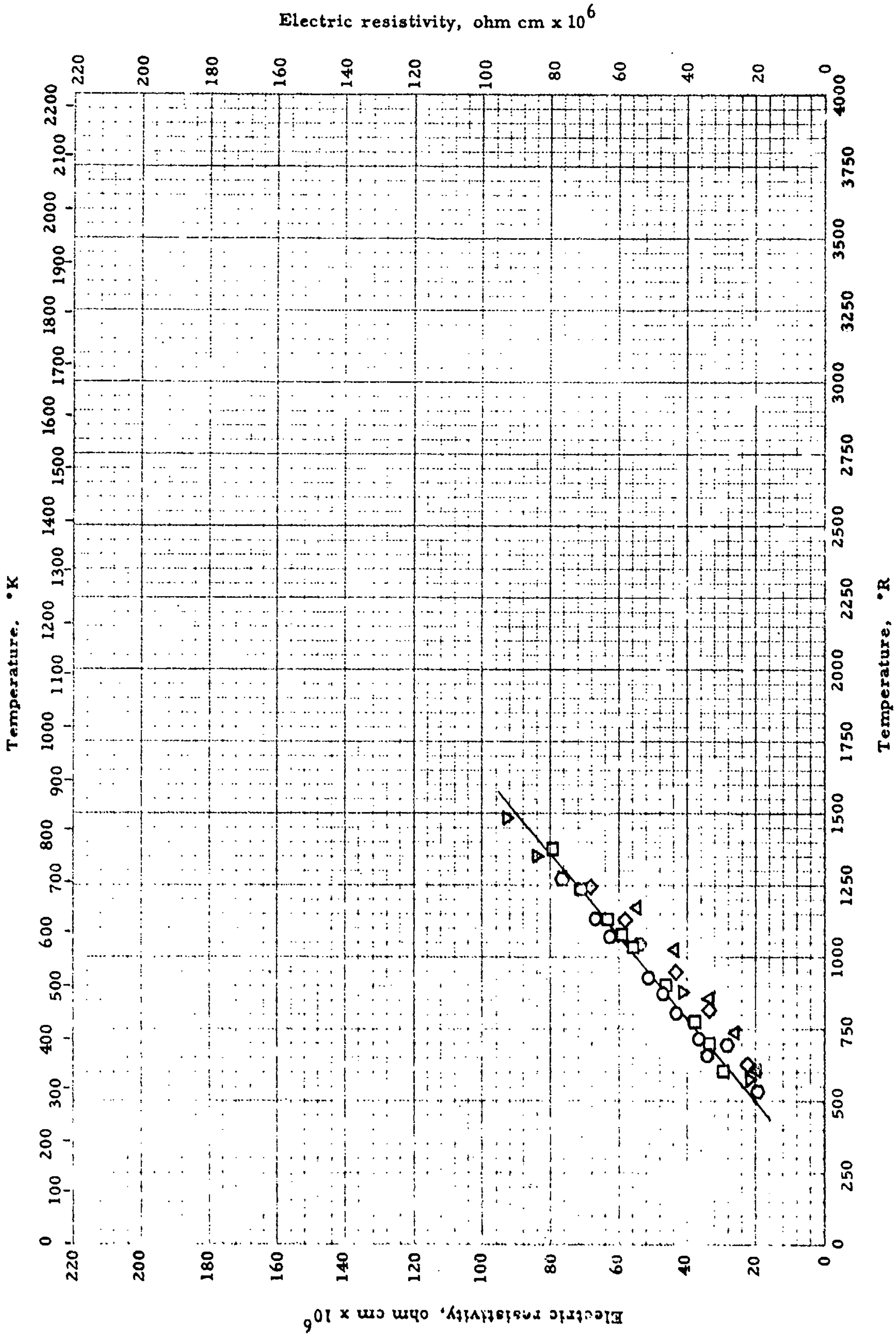


ELECTRIC RESISTIVITY -- IRON + VANADIUM
(0 to 10% V)

ELECTRIC RESISTIVITY -- IRON + VANADIUM
(0 to 10% V)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kornilov, I.I. and Mikheev, V.S.	55-124	537	0.0% V	Not given	Samples prepared from Fe + 0.02% C and 97% V + 1.5% Fe + 1% Al. Annealed 20 hr. at 1220°C, soaked 2 hr. at 1300-1320°C, quenched in ice water
□	Ibid.	55-124	537-672	4.8% V	Same as above	Same as above
△	Ibid.	55-124	537-672	8.1% V	Same as above	Same as above
◇	Ibid.	55-124	537-672	9.2% V	Same as above	Same as above
▽	Ibid.	55-124	537-672	9.9% V	Same as above	Same as above
○	Ibid.	55-124	537	0.0% V	Same as above	Samples prepared from Fe + 0.02% C and 97% V + 1.5% Fe + 1% Al. Annealed 70 hr. at 900°C, air cooled
□	Ibid.	55-124	537-672	4.8% V	Same as above	Same as above
△	Ibid.	55-124	537-672	8.1% V	Same as above	Same as above
◇	Ibid.	55-124	537-672	9.2% V	Same as above	Same as above
▽	Ibid.	55-124	537	9.8% V	Same as above	Same as above



ELECTRIC RESISTIVITY -- POROUS IRON + GRAPHITE + X ANTI-FRICTION ALLOYS

ELECTRIC RESISTIVITY -- POROUS IRON + GRAPHITE + X ANTIFRICTION ALLOYS

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E., and Pozdnyak, N. Z.	54-50	657-1137	95.76% Fe; 1.43% FeO; 1.13% C; 0.8% Fe_2O_3; 0.43% Mn; 0.4% Si; porosity 17%	Potential drop	Sintered 1.5 hr. at 1150°C in H_2 atmos.
□	Ibid.	54-50	604-1372	91.84% Fe; 5.[illegible]% Cu; 1.66% C; 0.44% Mn; 0.35% Si; 0.30% (FeO + Fe_2O_3); porosity 17%	Same as above	Same as above
△	Mikryukov, V. E. and Pozdnyak, N. Z.	53-103	605-1188	96.84% Fe_{met}; 1.5% Fe_2O_2; 0.65% FeO, 0.60% Si; 0.35% Mn; 0.06% C; porosity by wt. 5.1%	Potential drop	Auth. claim $\pm$ 1% accuracy. Pressed, heated in H_2 atmos to 1150°C in steps; furnace cooled to 800°C then H_2 stream cooled to room temp.
◇	Ibid.	53-103	616-1247	96.553% Fe_{met}; 1.9% Fe_2O_3; 0.70% Si; 0.4% FeO; 0.35% Mn; 0.09% C; porosity by wt. 14.3%	Same as above	Same as above
▽	Ibid.	53-103	590-1432	96.47% Fe_{met}; 1.9% Fe_2O_3; 0.6% FeO; 0.59% Si; 0.35% Mn; 0.087% C; porosity by wt. 17.0%	Same as above	Same as above
⬡	Ibid.	53-103	585-1266	96.45% Fe_{met}; 1.8% Fe_2O_3; 0.7% FeO; 0.60% Si; 0.35% Mn; 0.18% C; porosity by wt. 11.4%	Same as above	Same as above

PROPERTIES OF IRON + CHROMIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 28% Cr	475 lb_m/ft^3	7.58 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

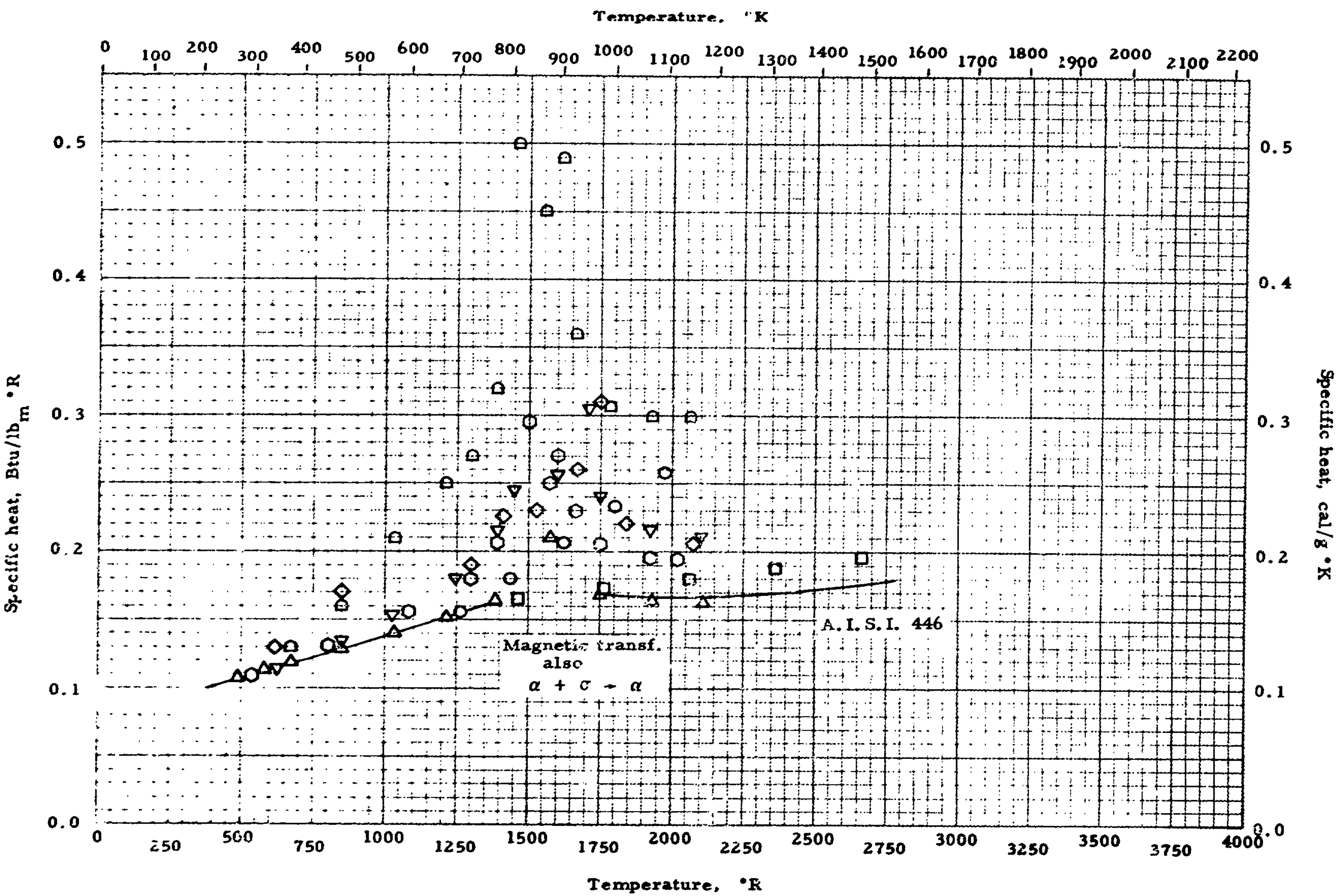
REPORTED VALUES

Density:	lb_m/ft^3	g/cm^3
O	474	7.58
Melting Point:	°R	°K
Heat of Fusion:	Btu/lb_m	cal/g
Heat of Vaporization:	Btu/lb_m	cal/g
Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	Room	AISI 446 Stainless steel; 70.55% Fe; 27.61% Cr; 0.086% C; 0.01% Mo	ρ : not given	

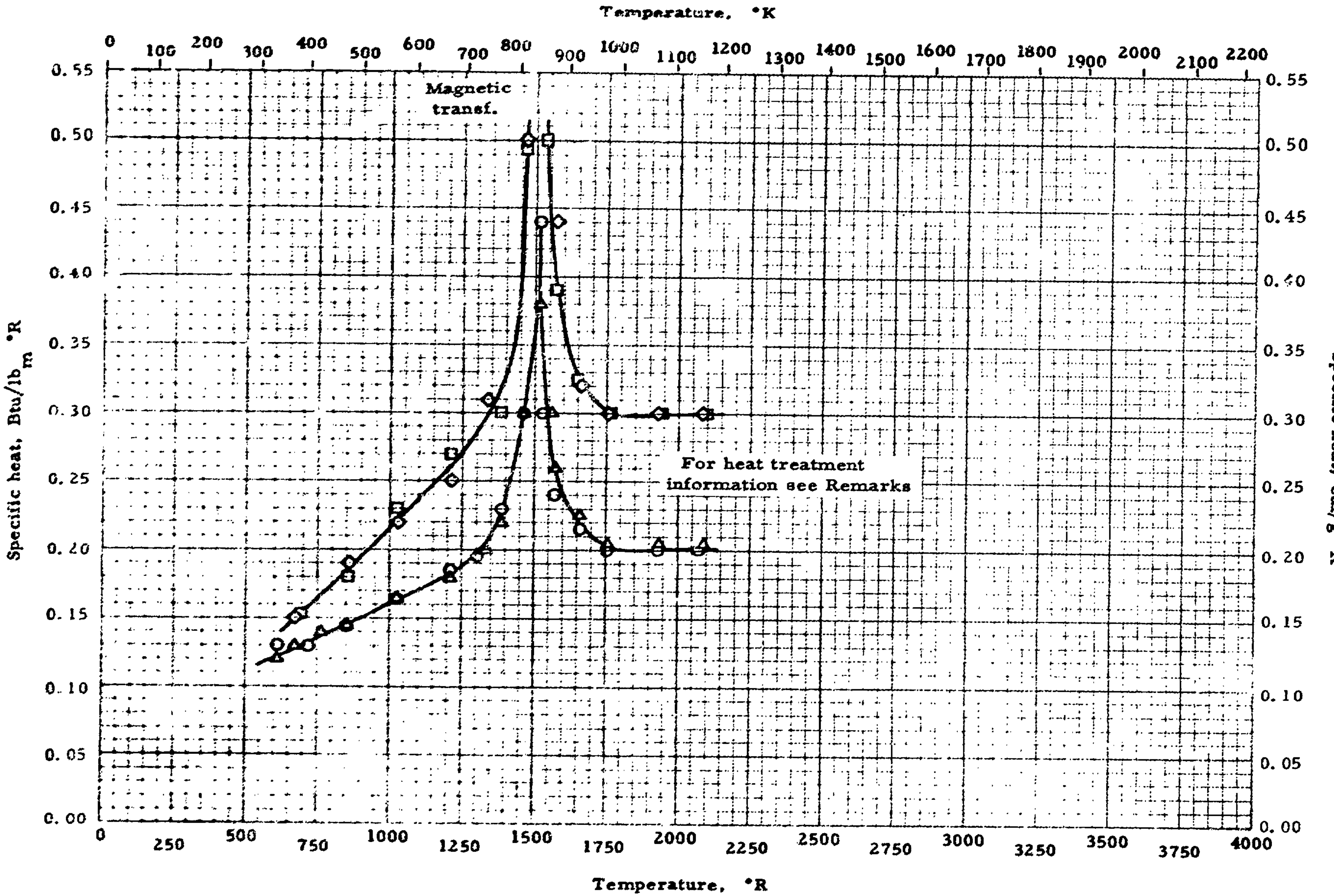


SPECIFIC HEAT -- IRON + CHROMIUM
(14 - 27% Cr)

SPECIFIC HEAT -- IRON + CHROMIUM
(14 - 27% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Stull, D.R. and McDonald, R.A.	55-31	1200-1980	AISI 430; nominal: 14-18% Cr	Drop method, Cu block calorimeter	
□	Fieldhouse, I.B., Hedge, J.C. et al.	58-4	1460-2660	AISI 446; before test: 27.61% Cr; 0.086% C; 0.01% Mo; after test: 27.64% Cr; 0.066% C; 0.01% Mo; ρ = 473 lb_m/ft^3	Drop method; liquid calorimeter	Tested in He atmos.
△	Douglas, T.B. and Dever, J.L.	55-16 also 53-39	492-2112	AISI 446; 25.58% Cr; 0.68% Si; 0.42% Mn; 0.32% Ni; 0.23% C; 0.019% P; 0.016% S	Drop method; ice calorimeter	Auth. est. accuracy ± 2-3%
◇	Masumoto, H., Saito, H. and Sugihara, M.	53-129	610-2112	15.02% Cr; 0.31% Si; 0.045% N; 0.041% C	Not described here; refers to others	Heated 3 hr. at 1000 °C in vac. electric furnace, furnace cooled to 800 °C; cooled to room temp. at 30 °C/hr.
▽	Ibid.	53-129	610-2112	19.21% Cr; 0.34% Si; 0.10% N; 0.049% C	Same as above	Same as above
○	Ibid.	53-129	610-2112	24.31% Cr; 0.38% Si; 0.058% C; 0.040% N	Same as above	Same as above
◌	Ibid.	53-129	610-2112	Same as above	Same as above	Same as above but also heated 200 hr. at 475 °C

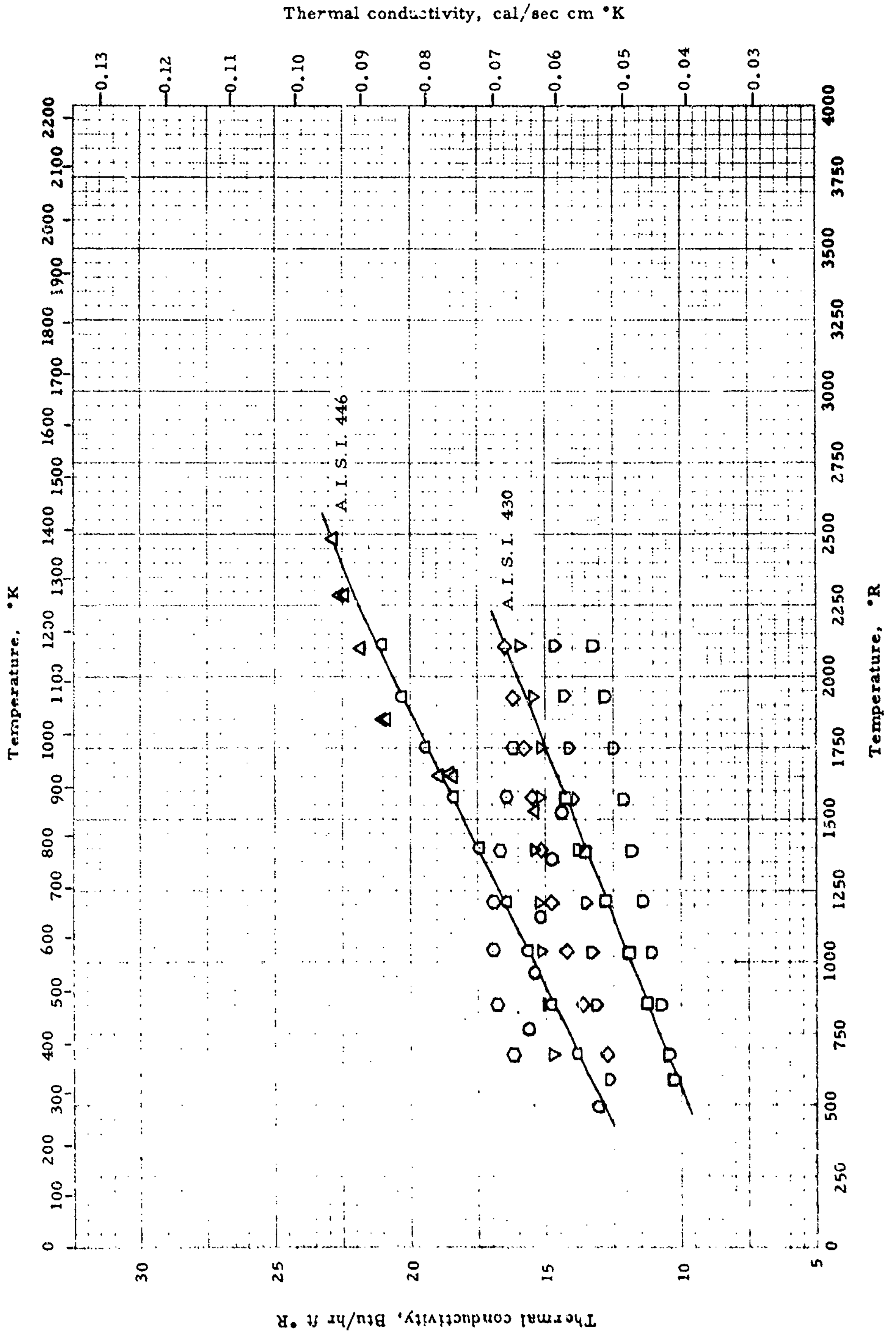


SPECIFIC HEAT -- IRON + CHROMIUM
(29 - 35% Cr)

SPECIFIC HEAT -- IRON + CHROMIUM
(29 - 35% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Masumoto, H., Saito, H. and Sugihara, M.	53-129	618-2076	28.58% Cr; 0.45% Si; 0.068% C; 0.035% N	Not described here, refers to others	Heated 3 hr. at 2292°R, furnace cooled to 1932°R, cooled to room temp. at 54°R per hr.
□	Ibid.	53-129	672-2076	Same as above	Same as above	Same as above; heated 200 hr. at 1347 °R
△	Ibid	53-129	618-2094	35.54% Cr; 0.43% Si; 0.058% C; 0.040% N	Same as above	Heated 3 hr. at 2292°R, furnace cooled to 1932°R, cooled to room temp. at 54°R per hr.
◇	Ibid.	53-129	672-2094	Same as above	Same as above	Same as above; heated 200 hr. at 1347°R

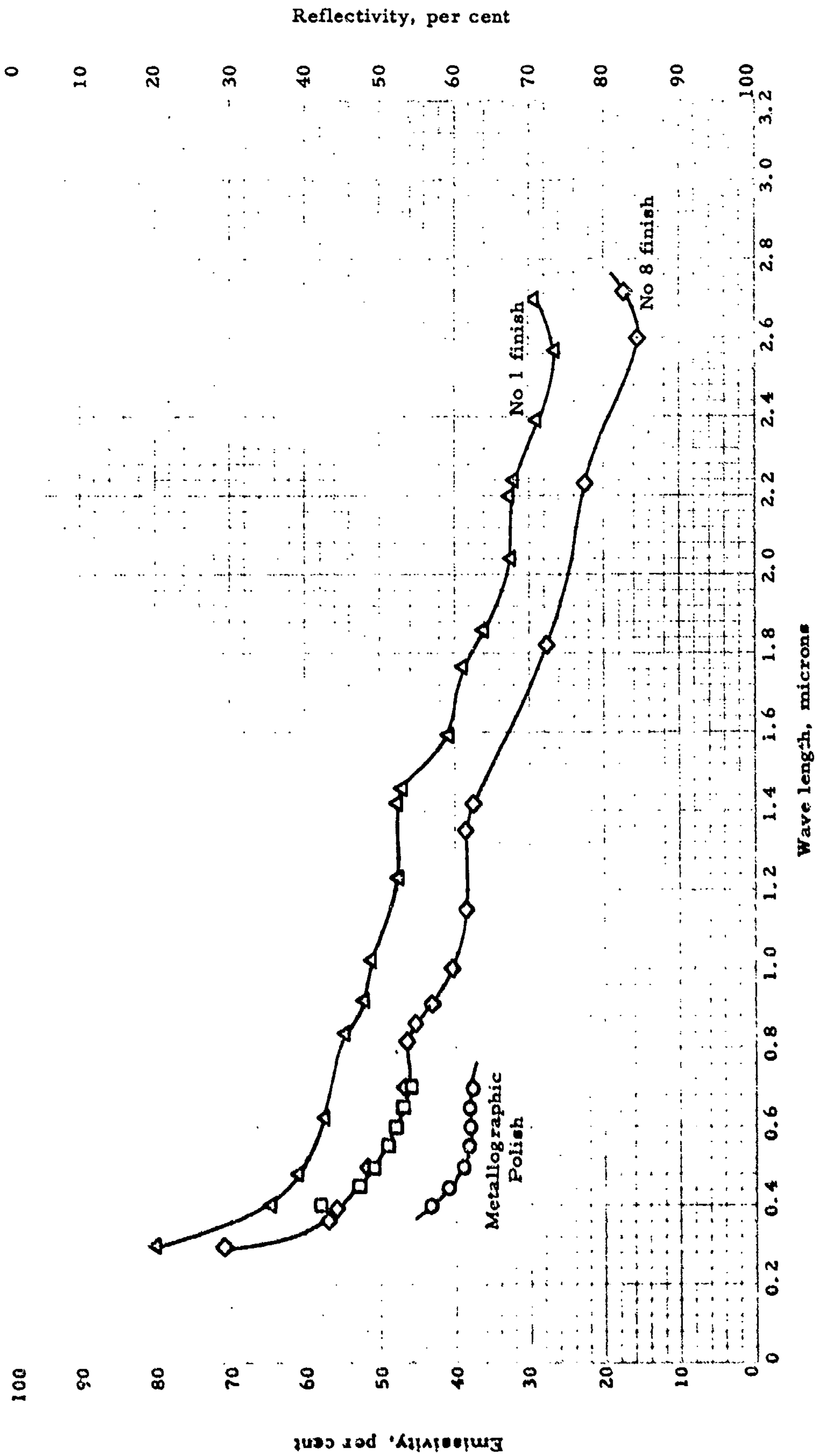


THERMAL CONDUCTIVITY -- IRON + CHROMIUM

THERMAL CONDUCTIVITY -- IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Evans, Jr., J. E.	51-16	365-1520	AISI 403; 12.0% Cr; 0.15% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%
□	Francis, R. K., McNamara, E. P., and Tinklepaugh, J. R.	58-7	852-1572	AISI 430; Nominal: 14 - 18% Cr	Comparative; rods (Al_2O_3 standard)	Standard supplied by W. D. Kingery
△	Fieldhouse, I. B., Hedge, J. C., et al.	58-4	1535-2485	AISI 446. Before test: 70.55% Fe; 27.61% Cr; 0.086% C; 0.01% Mo. After test: 70.59% Fe; 27.64% Cr; 0.066% C; 0.01% Mo. ρ = 473.5 lb_m/ft^3	Single flat plate, boiling liquid calorimeter	Tested in He atmos.
◇	Neimark, B. E.	55-68	672-2112	13.2% Cr; 0.40% Mn; 0.35% Si; 0.17% C;	Temp. distribution in resistance heated rod	Quenched
▽	Ibid.	55-68	672-2112	Same as above	Same as above	Tempered
○	Ibid.	55-68	672-1752	13.29% Cr; < 0.6% Ni; 0.59% Si; 0.52% Mn; 0.36% C	Same as above	Same as above
○	Hogan, C. L., and Sawyer, R. B.	52-75	492-2112	AISI 446. 26.0% Cr; 0.56% Mn; 0.50% Si; 0.14% N; 0.13% C; 0.10% Ni; 0.007% S	Temp. distribution in rod heated at one end; meas. heat loss from surface	
▽	Silverman, L.	53-2	582-2112	AISI 430; 82.4% Fe; 17.2% Cr; 0.254% Mn; 0.102% C; 0.035% S	Comparative; rods. Pb primary standard; "Advance" working standard	
○	Ibid.	53-2	582-2112	AISI 446; 76.44% Fe; 23.58% Cr; 0.152% C; 0.043% Mn; 0.021% S	Same as above	

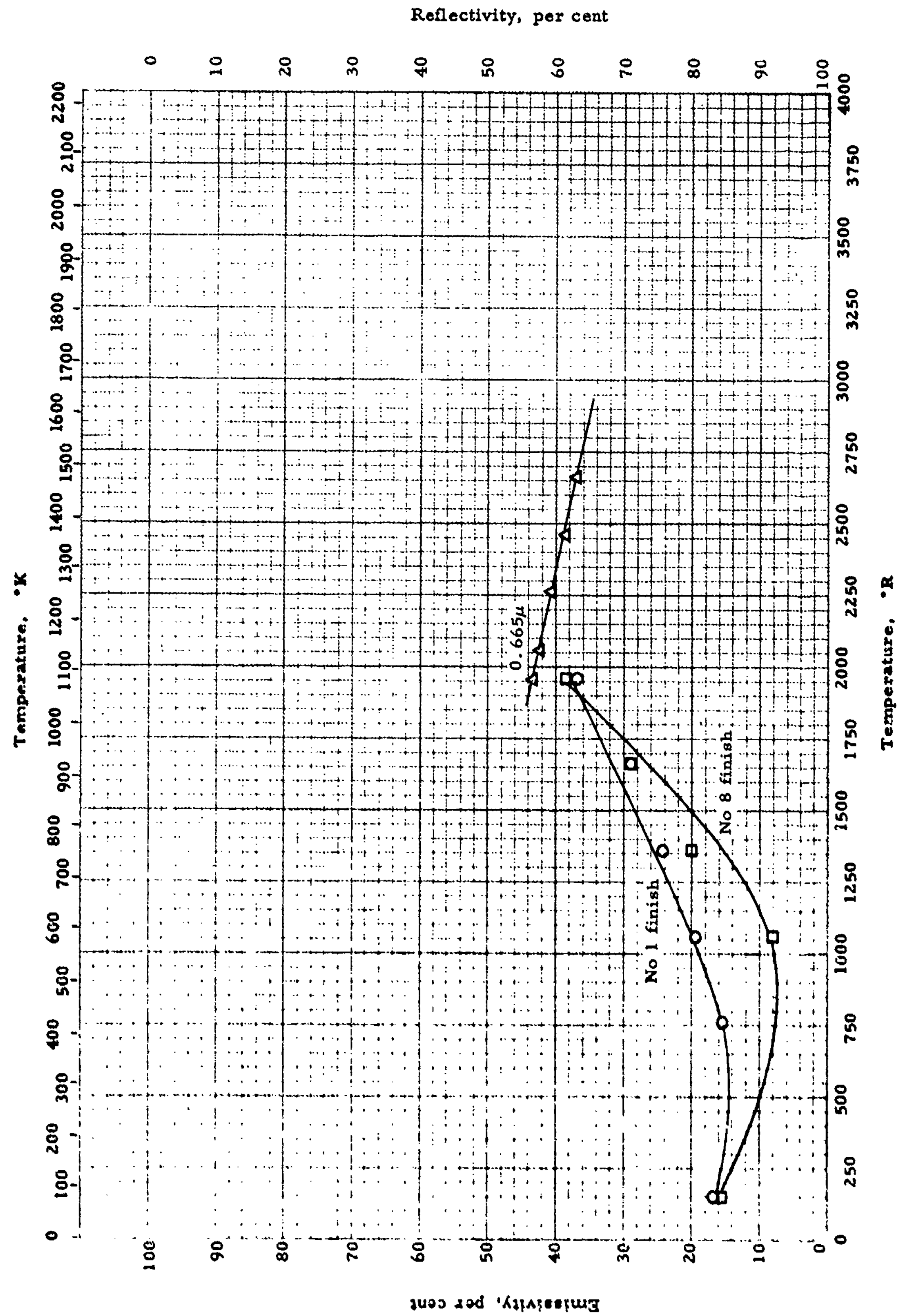


SPECTRAL EMISSIVITY -- IRON + CHROMIUM

SPECTRAL EMISSIVITY -- IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bloom, F.K.	53-88	Room	17% Cr	Spectral reflectivity (0.4-0.7μ); Harding recording spectrophotometer	Metallographic polish
□	Ibid.	53-88	Room	Same as above	Same as above	Ground, No. 000 Emery; polished on cloth wheel with commercial cutting compound; buffed on cloth wheel with chrome oxide coloring compound
△	Betz, H.T., Olson, O.H., et al.	57-8	Room	Stainless Steel Type 446. Nominal: 23-27% Cr; <1.5% Mn; <1.00% Si; <0.5% Ni; <0.25% N_2; <0.20% C	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 1, 15 microinch RMS
◇	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS

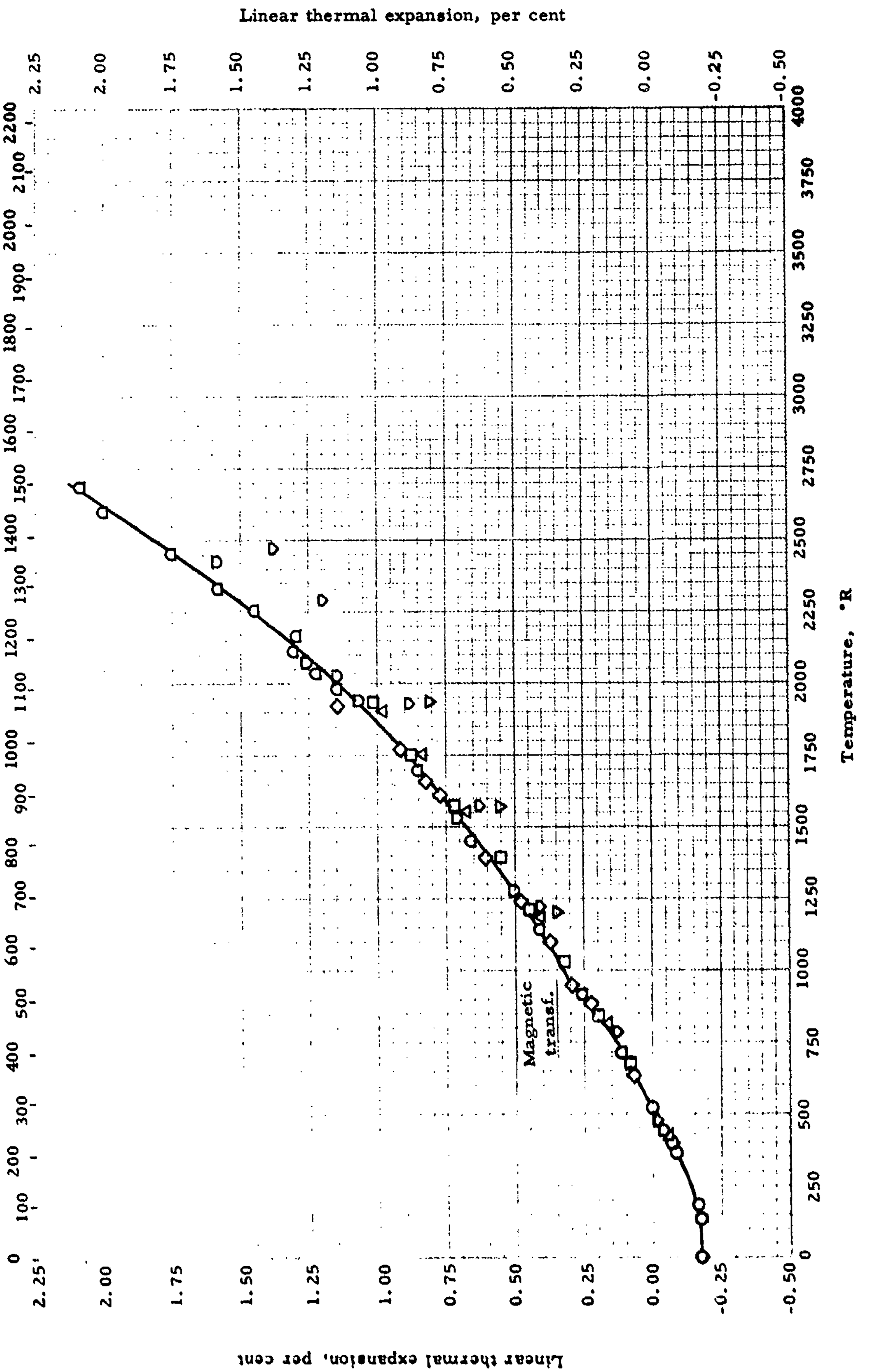


EMISSIVITY -- IRON + CHROMIUM

EMISSIVITY -- IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., and Olson, O.H., et al.	57-8	150-1960	Stainless Steel Type 446. Nominal: 23-27% Cr; <1.5% Mn; <1.00% Si; <0.5% Ni; <0.25% N_2; <0.20% C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	150-1960	Same as above	Same as above	Finish No. 8, 2 microinch RMS
△	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Finish No. 1 and 8



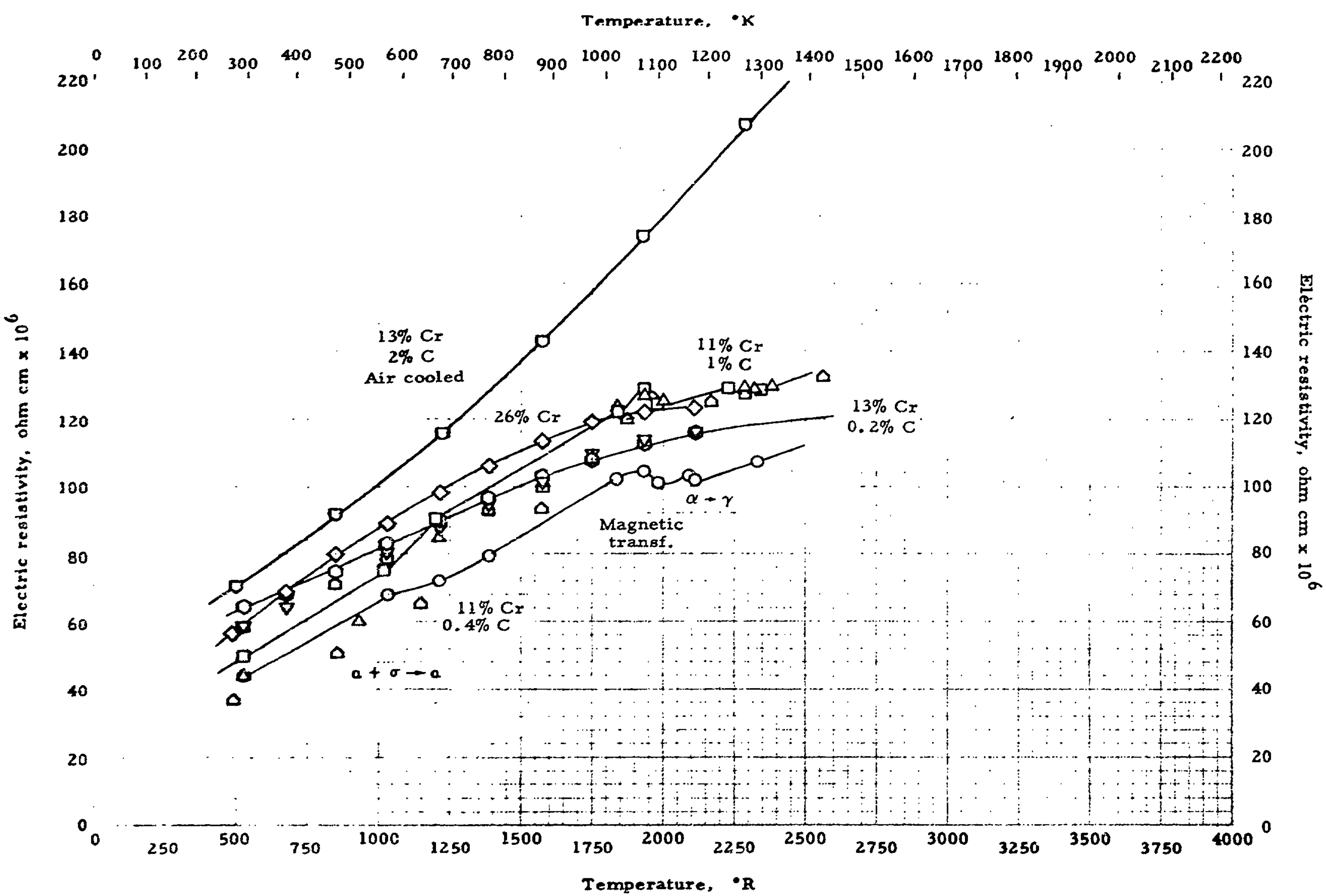
LINEAR THERMAL EXPANSION -- IRON + CHROMIUM

60-81
WADC TR 58-476

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Laquer, H. L.	52-39	0-540	410 Stainless Steel Nominal: 11.5 - 13.5% Cr; 0.15% C max.	Fizeau interferometer	Unpublished work by Altman, Rubin and Johnston
□	Neimark, B. E.	55-68	528-1932	4 samples: 1) 12.8% Cr; 0.6% Ni; 0.38% Mn; 0.28% Si; 0.26% C 2) 13.2% Cr; 0.40% Mn; 0.35% Si; 0.17% C 3) 13.29% Cr; 0.6% Ni; 0.59% Si; 0.52% Mn; 0.36% C 4) 13.6% Cr; 0.36% Mn; 0.33% Si; 0.11% C	Quartz dilatometer with induction transducer	Heated at 120°C/hr. Auth. est. accuracy ± 1.5%. Points shown are mean values with max. deviation of 4%. All specimens were high temp. tempered. Sample 2 was also tested and quenched
△	Cornelius, H.	43-17	528-1932	2 samples: 1) 13 - 16% Cr; 0.15 - 0.25% C; <0.8% Si; 0.3 - 0.5% Mn 2) 13 - 16% Cr; 0.35 - 0.50% C; 0.5 - 0.7% Si; 0.3 - 0.5% Mn	Quartz differential dilatometer with pyros standard, Leitz-Bollenrath	Points shown are mean values with max. deviation of 2%
◇	Kuz'menko, P. P.	55-81	528-1932	82.9% Fe; 16.8% Cr; 0.07% Mn; 0.05% C; 0.01% Si	X-ray diffraction	Sample annealed at 1200°C for 70 hr.
▽	Kornilov, I. I., Mikheev, V. S., et al.	46-9	528-2472	20% Cr; 0.02 - 0.04% C; 0.008% S; 0.08 - 0.15% Si	Dilatometer with dial gauge	Annealed
○	Perry, S.	45-6	360-528	No. 430 Stainless Steel: Nominal analysis: 14 - 18% Cr; 0.12% C max	Quartz tube dilatometer with dial gauge. Temp. meas. by thermocouples	
◺	Ibid.	45-6	360-528	No. 446 Stainless Steel: 23 - 27% Cr; 0.35% C max	Same as above	
◌	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	540-2688	No. 446 Stainless Steel: 70.55% Fe; 27.61% Cr; 0.86% C; 0.01% Mo	Telemicroscopes sighting on samples	
◌	Martens, H. and Duwez, P.	56-123	528-2472	55.3% Fe; 44.7% Cr	Dilatometer with 4°C/min. heating rate	100% α solid solution at start of test
◌	Ibid.	56-123	528-2472	Same as above	Same as above	100% α at start due to previous heat treatment



ELECTRIC RESISTIVITY -- IRON + CHROMIUM

ELECTRIC RESISTIVITY -- IRON + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Blanter, M. E.	47-13	528-2337	11.05% Cr; 0.43% C in form of $(Cr, Fe)_{23}C_6$	Potential drop	Auth. est. accuracy ± 2%. Samples annealed to granulated pearlite structure before test. Tested at 20°C /min. above 500°C
△	Ibid.	47-13	528-2382	10.86% Cr; 0.71% C in form of $(Cr, Fe)_7C_3 + (Cr, Fe)_{23}C_6$	Same as above	Same as above
□	Ibid.	47-13	528-2346	11.08% Cr; 1.01% C in form of $(Cr, Fe)_7C_3$	Same as above	Same as above
◇	Hogan, C. L., and Sawyer, R. B.	52-75	492-2112	SS 446. 26.0% Cr; 0.56% Mn; 0.50% Si; 0.14% N; 0.13% C; 0.10% Ni; 0.007% S	Potential drop; sample temp. by Chromel-alumel thermocouple	
▽	Neimark, B. E.	55-68	528-2112	13.2% Cr; 0.40% Mn; 0.35% Si; 0.17% C	Potential drop	Quenched
○	Ibid.	55-68	528-2112	Same as above	Same as above	Tempered
◠	Ibid.	55-68	528-1752	13.29% Cr; <0.6% Ni; 0.59% Si; 0.52% Mn; 0.36% C	Same as above	Tempered
⌂	Matsukura, T.	52-93	492-2526	13.23% Cr; 2.11% C; 0.64% Mn; 0.55% P: 0.34% Si; 0.013% S	Potential drop	Slowly heated and cooled at 100°C/hr
◡	Ibid.	52-93	492-2526	Same as above	Same as above	20 min. at 1130°C; air cooled to 500°C, then furnace cooled to room temp. Auth. also gives resistivity data for 9 other cooling rates, which fall between ⌂ and ◡

PROPERTIES OF IRON + CHROMIUM + NICKEL

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	490 lb_m/ft^3 *	7.8 g/cm^3 *
Melting Point	3060°R **	1700°K **
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Average value for engineering purposes. For individual stainless steels see Reported Values below.

** Value for HF grade alloy.

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3	Steel Type
○	484	7.75	HF grade
□	494.0	7.914	No. 301
△	493	7.90	No. 310

Melting Point:

	°R	°K	
○	3060	1700	HF grade

Heat of Fusion: Btu/lb_m cal/g

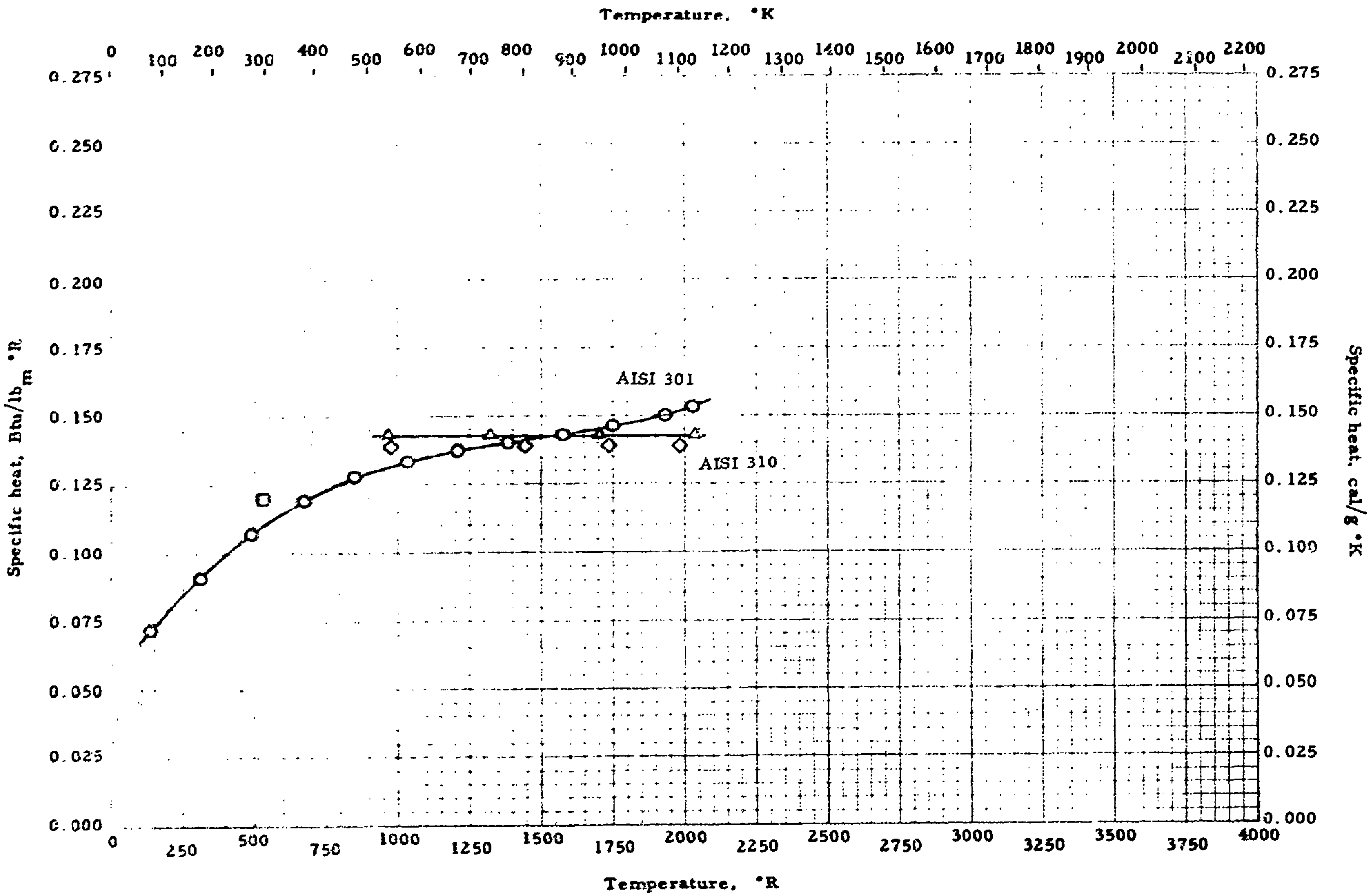
Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Schoefer, E. A.	53-35	Room 3060	HF grade alloy; nominal: 21% Cr; 9% Ni	ρ: not given MP: not given	Tests run at American Casting Institute
□	Lucks, C. F. and Deem, H. W.	58-5 also 51-65	528	Stainless steel type 301; nominal: 16-18% Cr; 6-8% Ni	ρ: weight and volume by water displacement	Hot rolled, annealed 1 hr. at 2360°R, water quenched
△	Seibel, R. D. and Mason, G. L.	57-156	Room	Stainless steel type 310: 46.58% Fe (by diff.); 24.94% Cr; 19.60% Ni; 1.57% Mn; 0.37% Si; 0.062% C; 0.018% ea P, S	ρ: not given	

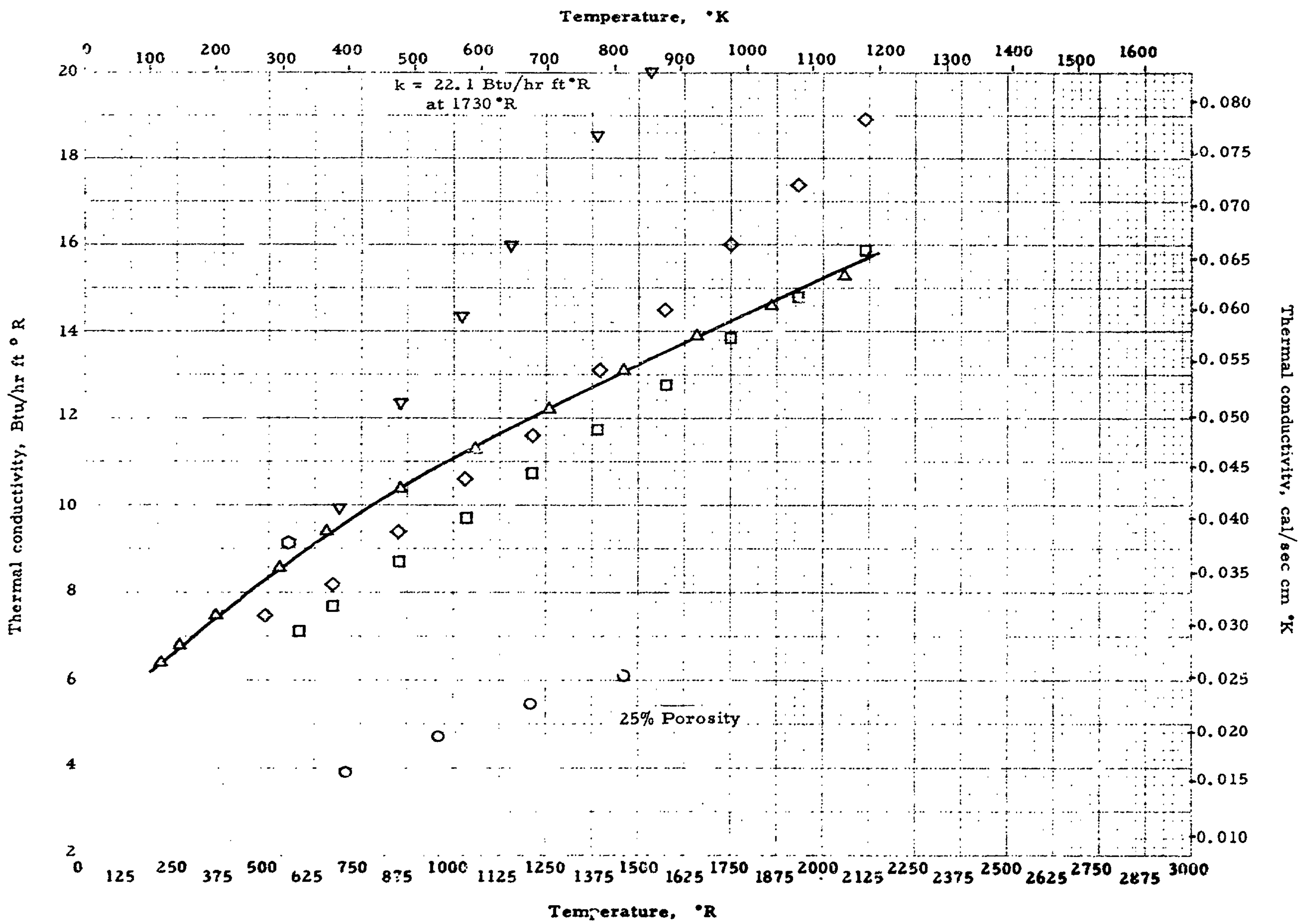


SPECIFIC HEAT -- IRON + CHROMIUM + NICKEL

SPECIFIC HEAT -- IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F., Matolich, J. and Van Valzor, J. A.	54-27 also 58-5	141-2022	AISI 301; nominal: 16-18% Cr; 6-8% Ni	Drop method; ice calorimeter	
□	Schoefer, E. A.	53-35	530	HF Grade Alloy; 21% Cr; 9% Ni	Not given	
△	Powers, W. D. and Blalock, G. C.	53-130	920-2036	AISI 310: 24.03% Cr; 16.96% Ni; 0.55% Si; 0.42% Mn; 0.13% ea. C, Cu; 0.033% Mo; 0.018% P; 0.01% ea. Ta, Co; <0.01% ea. W, Li, Hf; 0.008% S; <0.002% Cd; <0.001% B	Drop method; ice calorimeter	Auth. fitted a straight line to enthalpy vs. temp. data, making c_p a constant. Auth. est. accuracy $\pm$ 5%
◇	Ibid.	53-130	923-1993	AISI 310: 22.30% Cr; 19.14% Ni; 0.50% Mn; 0.43% Si; 0.12% C; 0.10% Cu; 0.042% Mo; 0.025% P; 0.01% Co; <0.01% W; 0.008% S	Same as above	Same as above

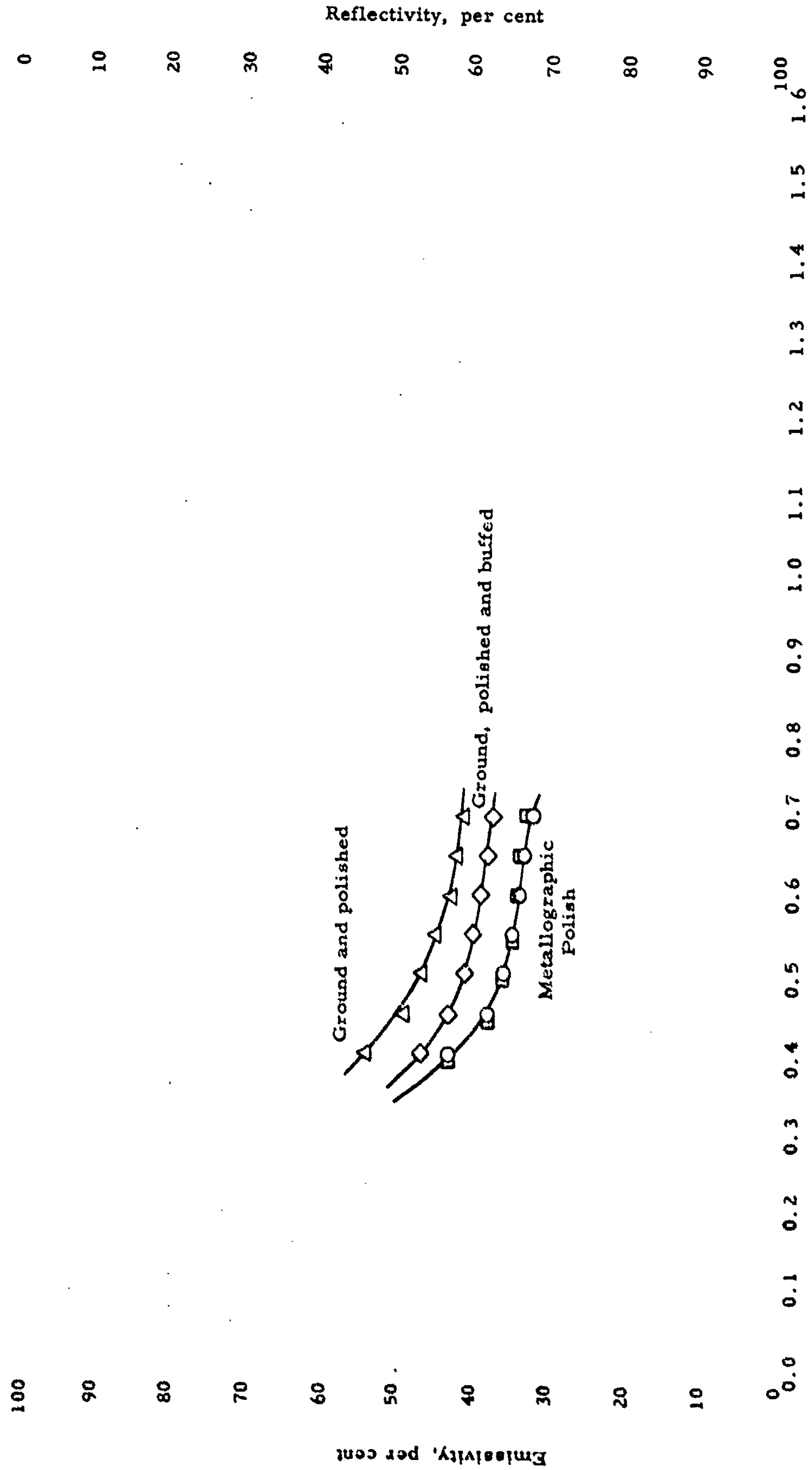


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Evans Jr., J. E.	51-16	710-1465	Porous AISI 301 (25% porosity); 17.0% Cr; 7.0% Ni; 0.11% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%
□	Silverman, L.	53-2	582-2112	AISI 302; 71.6% Fe; 18.40% Cr; 9.6% Ni; 0.13% Si; 0.116% C; 0.021% P; 0.013% S	Comparative; rods (Pb primary standard, "Advance" working standard)	
△	Lucks, C.F. and Deem, H. W.	58-5 51-65	210-2060	AISI 301	Comparative; rods; (Armco Iron standard)	Hot rolled, annealed 1 hr. at 1900 °F; water quenched
◇	Hogan, C.L. and Sawyer, R.B.	52-75	492-2112	Stainless Steel 310; 50.98% Fe; 25.54% Cr; 20.68% Ni; 1.83% Mn; 0.84% Si; 0.10% C; 0.025% P; 0.005% S	Temp. distribution in rod heated at one end; meas. heat loss from surface	
▽	Perova, V.I. and Knoroz, L.I.	57-117	684-1730	10% Cr; 9% Ni	Temp. distribution along resistance heated rod; Chromel-Alumel thermocouples	Sample forged, began at 1150°C, ended at 950°C, quenched in water from 1150°C. Aged 50 hr. at 100°C. Auth. est. accuracy ± 4%
○	Stuckes, A.D. and Chasmar, R.P.	57-130	564	Stainless Steel type 18-8: no composition given	Comparative, rods in vacuum	Fe standard. Contact resistance reduced by In amalgam

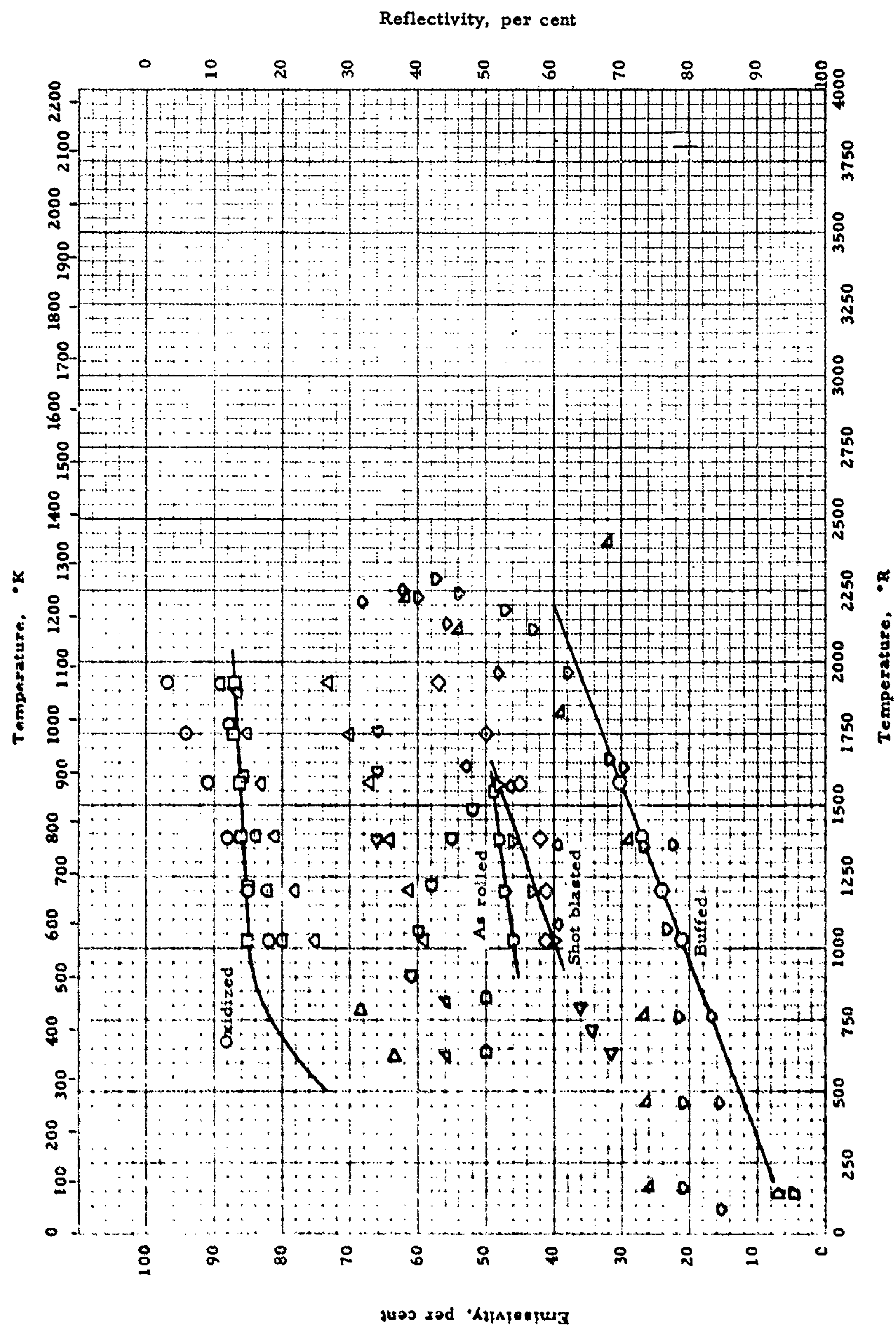


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bloom, F.K.	53-88	Room	Stainless steel: 18% Cr; 8% Ni; electro polish	Spectral reflectivity (0.4-0.7μ); Harding recording spectrophotometer	
□	Ibid.	53-88	Room	Same as above; metallographic polish	Same as above	
△	Ibid.	53-88	Room	Same as above; ground to No. 000 emery; polished on cloth buffing wheel using commercial cutting compound	Same as above	
◇	Ibid.	53-88	Room	Same as above; treated as above; followed by buffing on cloth wheel with chrome oxide coloring compound	Same as above	



EMISSIVITY -- IRON + CHROMIUM + NICKEL

EMISSIVITY -- IRON + CHROMIUM + NICKEL

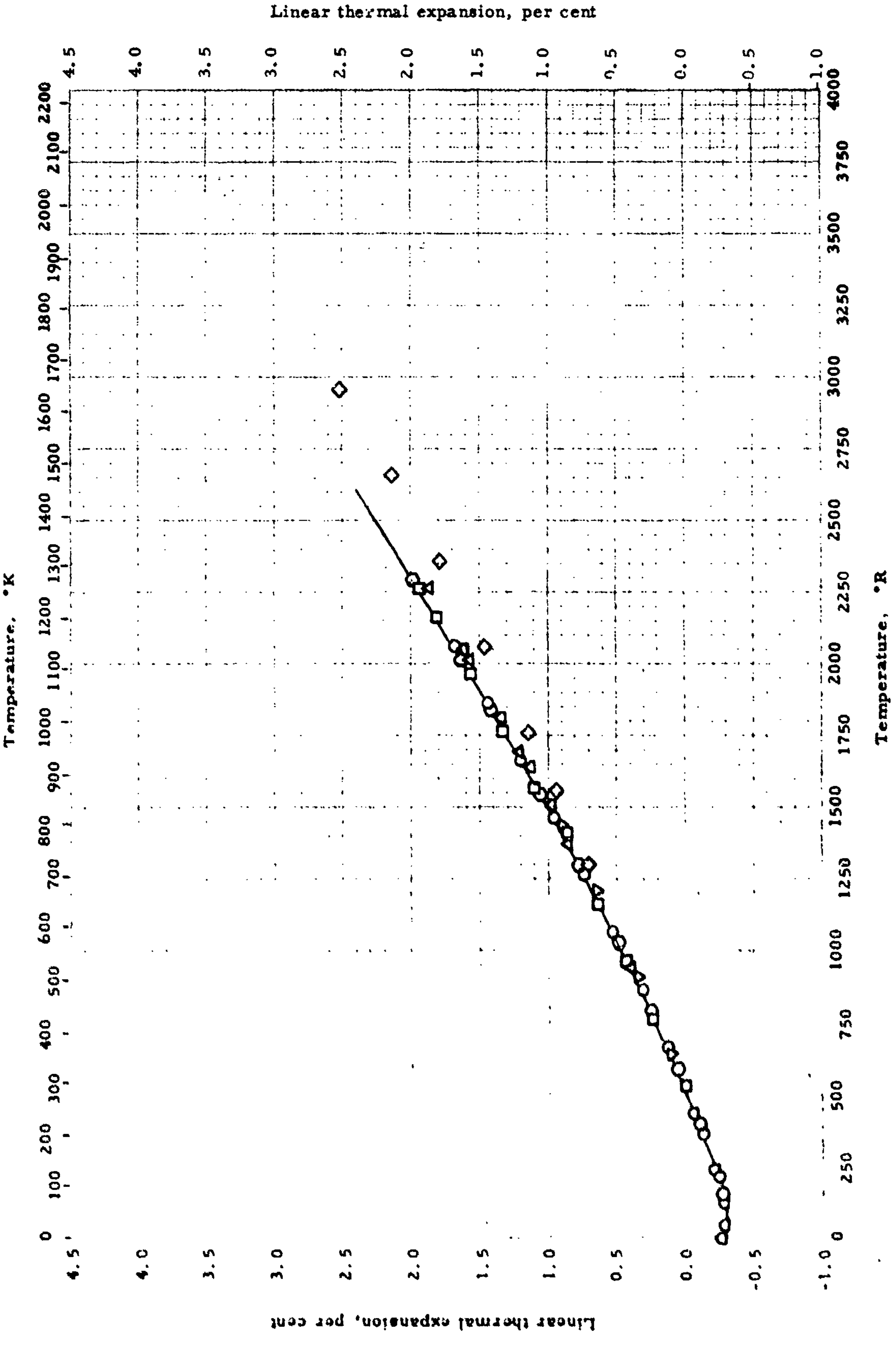
REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sully, A.H., Brandes, E.A. and Waterhouse, R.B.	52-81	1032-1932	18-8 Stainless Steel: Nominal: 18% Cr; 8% Ni	Total emissivity: radiant heat loss meas. with a thermopile; temp. with a thermocouple	Shot blasted; oxidized at 900°C
□	Ibid.	52-81	1032-1932	Same as above	Same as above	Buffed; oxidized at 900°C
	Ibid.	52-81	1032-1932	Same as above	Same as above	As rolled, oxidized at 900°C
△	Ibid.	52-81	1032-1932	Same as above	Same as above	Shot blasted; oxidized at 600°C
	Ibid.	52-81	1032-1932	Same as above	Same as above	Buffed; oxidized at 600°C
	Ibid.	52-81	1032-1932	Same as above	Same as above	As rolled; oxidized at 600°C
▽	Ibid.	52-81	1032-1932	Same as above	Same as above	Shot blasted; unoxidized
○	Ibid.	52-81	1032-1932	Same as above	Same as above	Buffed; unoxidized
	Ibid.	52-81	1032-1932	Same as above	Same as above	As rolled; unoxidized
	Wilkes, G. B.	54-122	160-2290	301 Stainless Steel. Nominal: 16.0 - 18.0% Cr; 6.00 - 8.00% Ni; 2.00% Mn max; 0.08 - 0.20% C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body. Used thermopile in vac. of 10μ Hg. Temp. by Chromel-Alumel and Cu-Const. thermocouples	As received: wiped with toluene until clean, then with methyl alcohol
	Ibid.	54-122	160-2410	Same as above	Same as above	Clean and smooth: scrubbed with Bon Ami, washed with water and dried, wiped with toluene, then with alcohol
	Ibid.	54-122	85-2250	Same as above	Same as above	Polished: buffed until mirror-like and free of scratches, washed with soap and dried
	Fulk, M.M. and Reynolds, M.M.	57-121	137	302 Stainless Steel. Nominal: 17.0 - 19.0% Cr; 8.00 - 10.00% Ni; 2.00% Mn max; 0.08 - 0.20% C	Total hemispherical absorptivity at 76°K: radiant heat meas. with boil-off of liquid N_2	Surfaces cleaned of grease and dirt, but retained normal oxide coat acquired at room temp.
	Ibid.	57-121	137	Same as above	Same as above	Commercial ball type 302. Same treatment as above

EMISSIVITY -- IRON + CHROMIUM + NICKEL (Cont'd)

REFERENCE INFORMATION

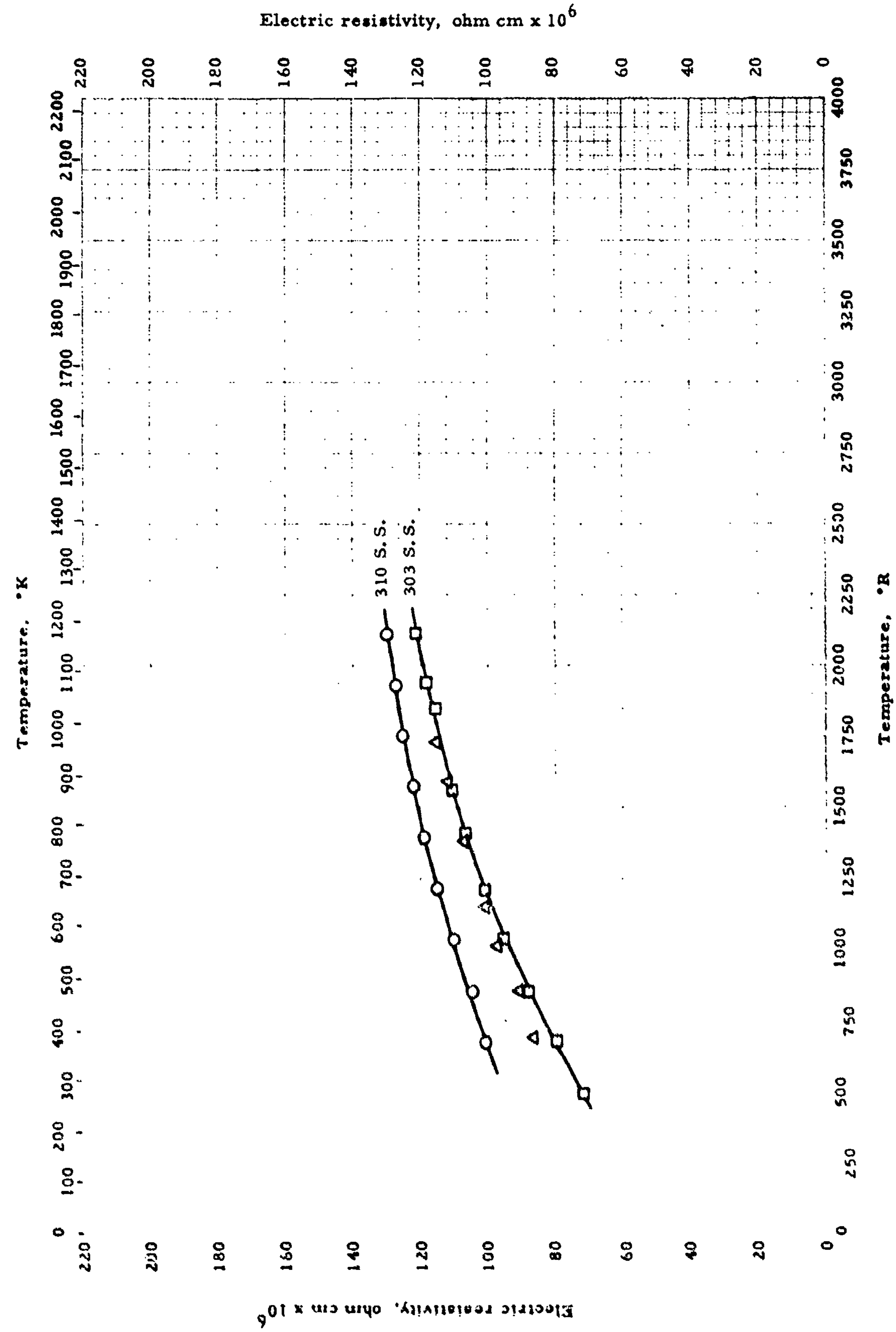
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dorward, J.G. and Reed, D.	44-8	1070-1643	18-8 Stainless Steel. Nominal: 18% Cr; 8% Ni	Total normal emissivity: power dissipation of wire in vacuum to concentric cylinder, with meas. electric input. Sample temp. by Fe-Const. thermocouple	Polished
◁	Ibid.	44-8	1397-1752	Same as above	Same as above	Polished, oxidized 2 hr. at 650°C
□	Ibid.	44-8	852-1482	Same as above	Same as above	Sprayed 18-8 SS on Cu
D	Boelter, L. M. K., Bromberg, R. and Gier, J. T.	44-10	640-820	18-8 Stainless Steel. Nominal: 18% C; 8% Ni	Total emissivity: radiant heat meas. with thermopile and radiometer	Sand blasted
◿	Ibid.	44-10	630-810	Same as above	Same as above	Chromic and sulphuric blackened
◁	Ibid.	44-10	640-800	Same as above	Same as above	Oxidized at 1000°F
▷	Ibid.	44-10	630-780	Same as above	Same as above	Oxidized at 1500°F



LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5	210-2060	AISI 301. Nominal: 16-18% Cr; 6-8% Ni	Quartz tube dilatometer	Hot rolled, annealed 1 hr. at 1900°F, water quenched. Tested in vacuum
□	M. W. Kellogg Co.	48-17	528-2260	AISI 304: 18.43% Cr; 9.67% Ni; 1.11% Mn; 0.53% Si; 0.16% Cu; 0.069% C; 0.023% P; 0.016% S	Dilatometer	Solution heat treated 3/4 hr. at 1990-2020°F; water quenched, aged 48-50 hr. at 1400°F
△	Sailer, H. A., et al.	53-127	960-2260	AISI 310: Nominal: 51.2% Fe; 25.0% Cr; 20.5% Ni; < 2.00% Mn; < 1.5% Si; < 0.25% C	Dilatometer	Arc melted, cast, heated for 24 hr. at 1800°F in vacuum. Data average of two heating and cooling cycles. Tested in vacuum.
◇	Seibel, R. D. and Mason, G. L.	57-156	1260-2960	AISI 310: 46.58% Fe; 24.94% Cr; 19.60% Ni; 1.57% Mn; 0.37% Si; 0.062% C; 0.018% ea. P, S	Alumina tube dilatometer	Calibrated using Cu and Mo; tested at 350°F/min in vacuum.
▽	Lefort, H. G., Spriggs, R. M. and Bennett, D. G.	56-97	546-1390	AISI 302: Nominal: 17.00-19.00% Cr; 8.00-10.00% Ni; 2.00% Mn max; 0.08-0.20% C	Interferometer	
○	Lucks, C. F., Thompson, H. B. et al.	51-65	150-2292	AISI 301: Nominal: 16.0-18.0% Cr; 6.00-8.00% Ni; 2.00% Mn max; 0.08-0.20% C	Quartz tube dilatometer	Hot rolled, annealed 1 hr. at 1900°F, water quenched.
◻	Laquer, H. L.	52-39	0-531	AISI 304: Nominal: 18-20% Cr, 8-11% Ni	Fizeau Interferometer	Work by Altman, Rubin, Johnston. Unpubl. 1949-1951.
⌂	Schoefer, E. A.	53-35	530-2060	HF Grade Alloy; 21% Cr; 9% Ni	Not given	



ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hogan, C.L. and Sawyer, R.B.	52-75	492-2112	Stainless steel 310. 50.98% Fe; 25.54% Cr; 20.68% Ni; 1.83% Mn; 0.84% Si; 0.10% C; 0.025% P; 0.005% S	Potential drop; sample temp. by Chromel-Alumel thermocouple	
□	Ibid.	52-75	492-2112	Stainless Steel 303. Nominal: 18.42% Cr; 8.97% Ni; 0.61% Mn; 0.51% Si; 0.17% C	Same as above	
△	Perova, V.I. and Knoroz, L.I.	57-117	684-1730	19% Cr; 9% Ni	Potential drop, temp. by Chromel-Alumel thermocouple	Forged, quenched in water from 1150°C. Aged 50 hr. at 100°C. Auth. est. accuracy ± 1%

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	512 lb_m/ft^3	8.20 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3	
○	512	8.20	Multimet Alloy
□	502	8.055	DVL 46
△	488.5	7.825	DVL 50
◇	501.1	8.027	DVL 47
▽	504.5	8.082	DVL 49
⬡	496.9	7.959	DVL 48
⌂	508	8.13	Jessop G18B

Melting Point: °R °K

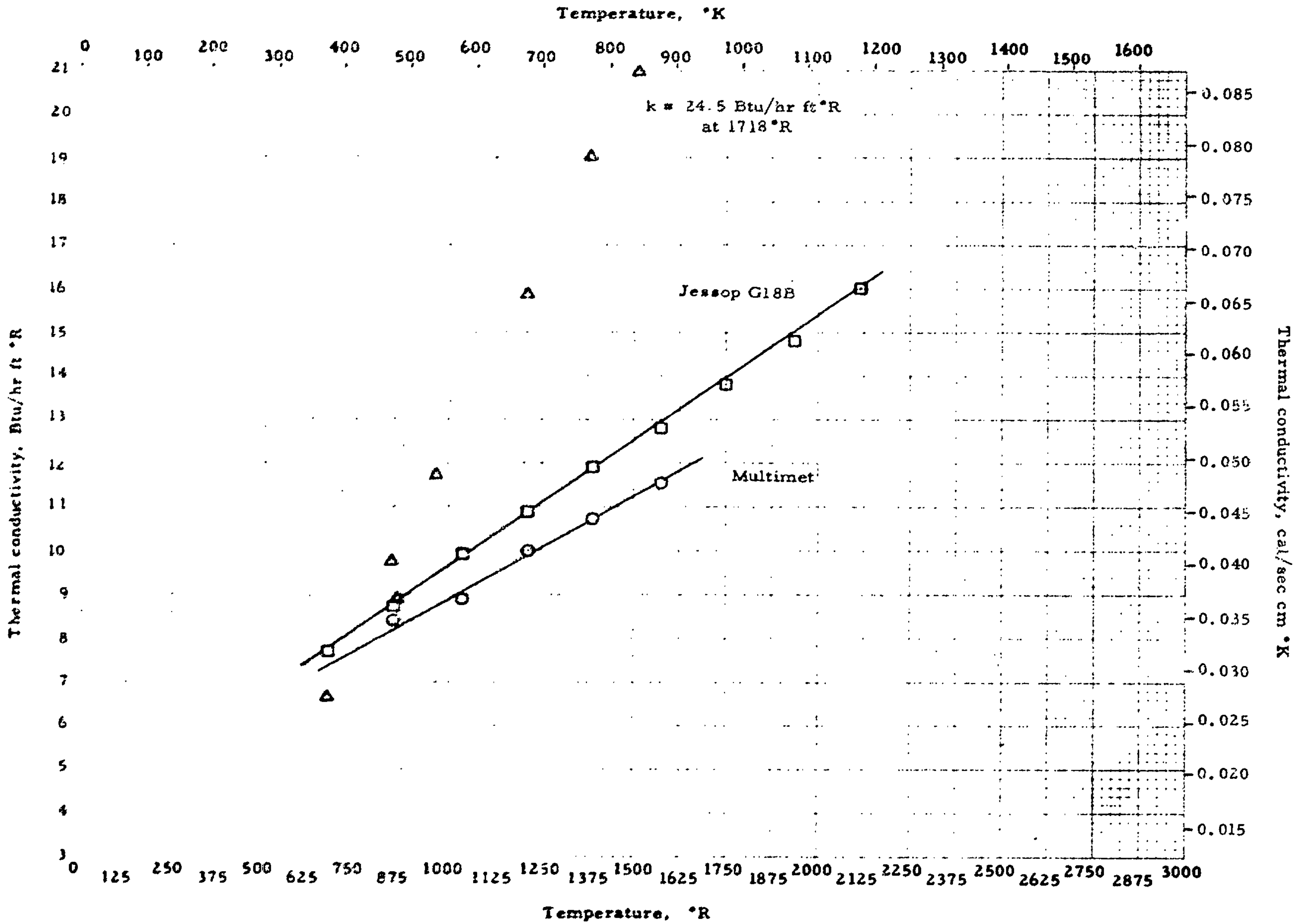
Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeney, W. O.	50-14 also 47-14	Room	Multimet alloy (NR-21; AMS-5532b) nominal: 33% Fe; 20 - 22.5% Cr; 19 - 21% Ni; 18.5 - 21% Co; 2.5 - 3.5% Mo; 2 - 3% W; 0.75 - 1.25% Nb + Ta; 0.1 - 0.2% N_2; 0.08 - 0.16% C	ρ: not given	Wrought; data from Union Carbide and Carbon
□	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	Room	DVL 46 (German desig.): 54.3% Fe; 19.2% Cr; 14.2% Ni; 5.2% Co; 4.5% W; 1.5% Si; 0.6% Mn; 0.41% C	ρ: not given	
△	Ibid.	47-8	Room	DVL 50 (German desig.): 54.2% Fe; 20.0% Cr; 14.4% Ni; 6.45% Co; 2.7% V; 1.03% Si; 0.86% Mn; 0.44% C	ρ: not given	
◇	Ibid.	47-8	Room	DVL 47 (German desig.): 51.2% Fe; 27.7% Cr; 13.7% Ni; 4.7% Co; 1.5% Si; 0.75% Mn; 0.46% C	ρ: not given	
▽	Ibid.	47-8	Room	DVL 49 (German desig.): 50.0% Fe; 19.7% Cr; 14.5% Ni; 11.1% Co; 2.98% W; 0.68% Si; 0.56% Mn; 0.44% C	ρ: not given	
○	Ibid.	47-8	Room	DVL 48 (German desig.): 48.2% Fe; 25.8% Cr; 12.7% Ni; 4.95% Co; 3.6% W; 3.3% Si; 0.72% Mn; 0.42% C; 0.28% Ti	ρ: not given	
○	Ibid.	47-8	Room	Jessop G18B steel (British desig.): 13.09% Ni; 13.0% Cr; 10.0% Co; 3.0% Nb; 2.5% W; 1.0% Si; 0.8% Mn; 0.4% C	ρ: not given	

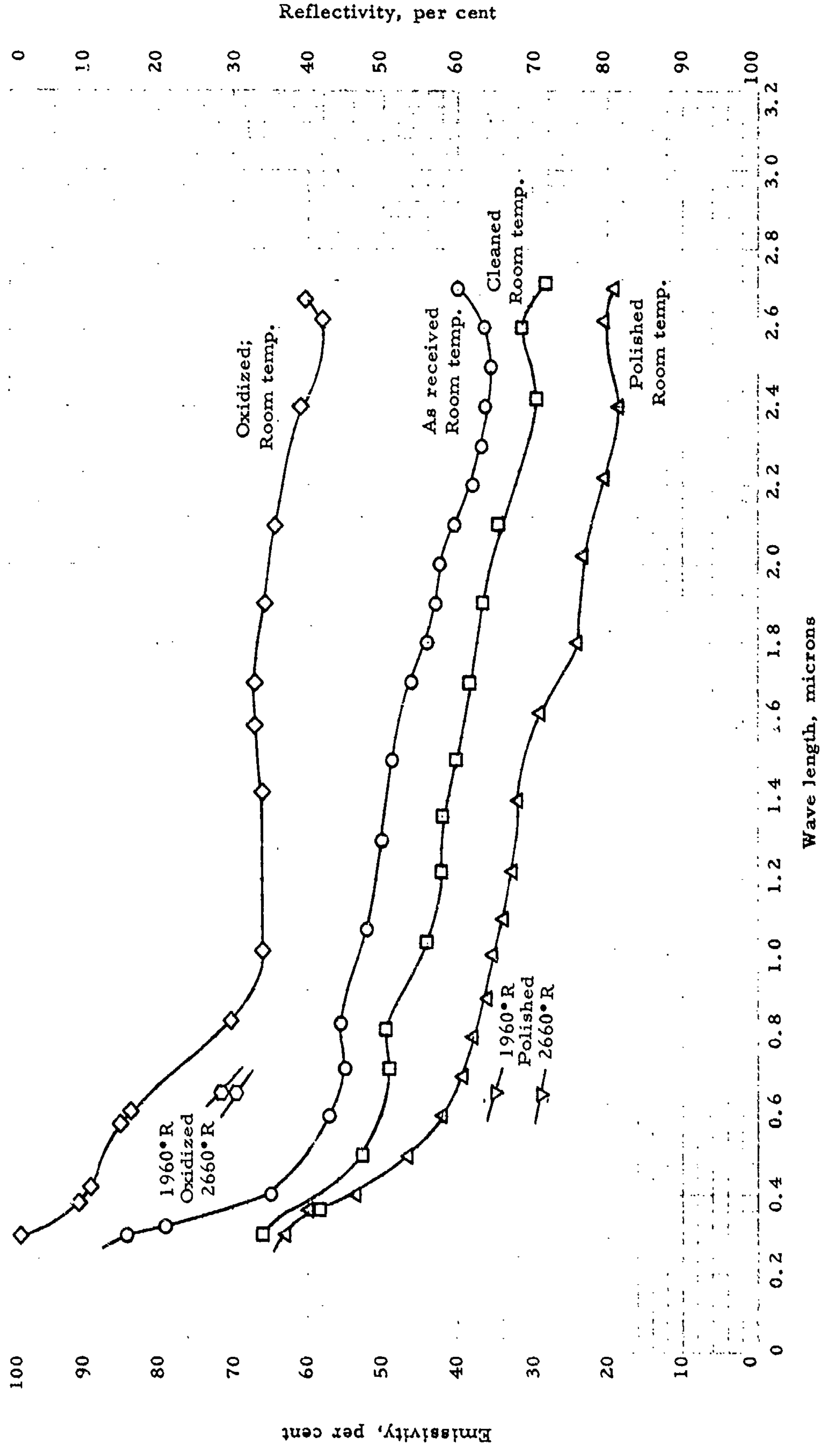


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeny, W.O.	50-14 also 47-14	852-1572	Multimet Alloy - Wrought: 20.0 - 22.5% Cr; 19.0 - 21.0% Ni; 18.5 - 21.0% Co; 2.5 - 3.5% Mo; 2.0 - 3.0% W; 0.75 - 1.25% (Nb + Ta); 0.10 - 0.20% N_2; 0.08 - 0.16% C	Not given; probably comparative; rods	Data obtained by Battelle Memorial Institute
□	Oliver, D.A. and Harris, M.A.	52-25	528-2172	Jessop G18B Steel (Brit. Desig.); 13.0% Cr; 13.0% Ni; 10.0% Co; 3.0% Nb; 2.5% W; 2.0% Mo; 1.0% Si; 0.8% Mn; 0.4% C	Not given	
△	Perova, V.I. and Knoroz, L.I.	57-117	671-1718	20% Cr; 20% Ni; 20% Co	Temperature distribution in resistance heated rod, Chromel-Alumel thermocouples	Sample forged, began at 1180°C, ended at 950°C, quenched in oil from 1200°C. Aged 70 hr. at 760°C. Auth. est. accuracy ± 4%. Data probably high.

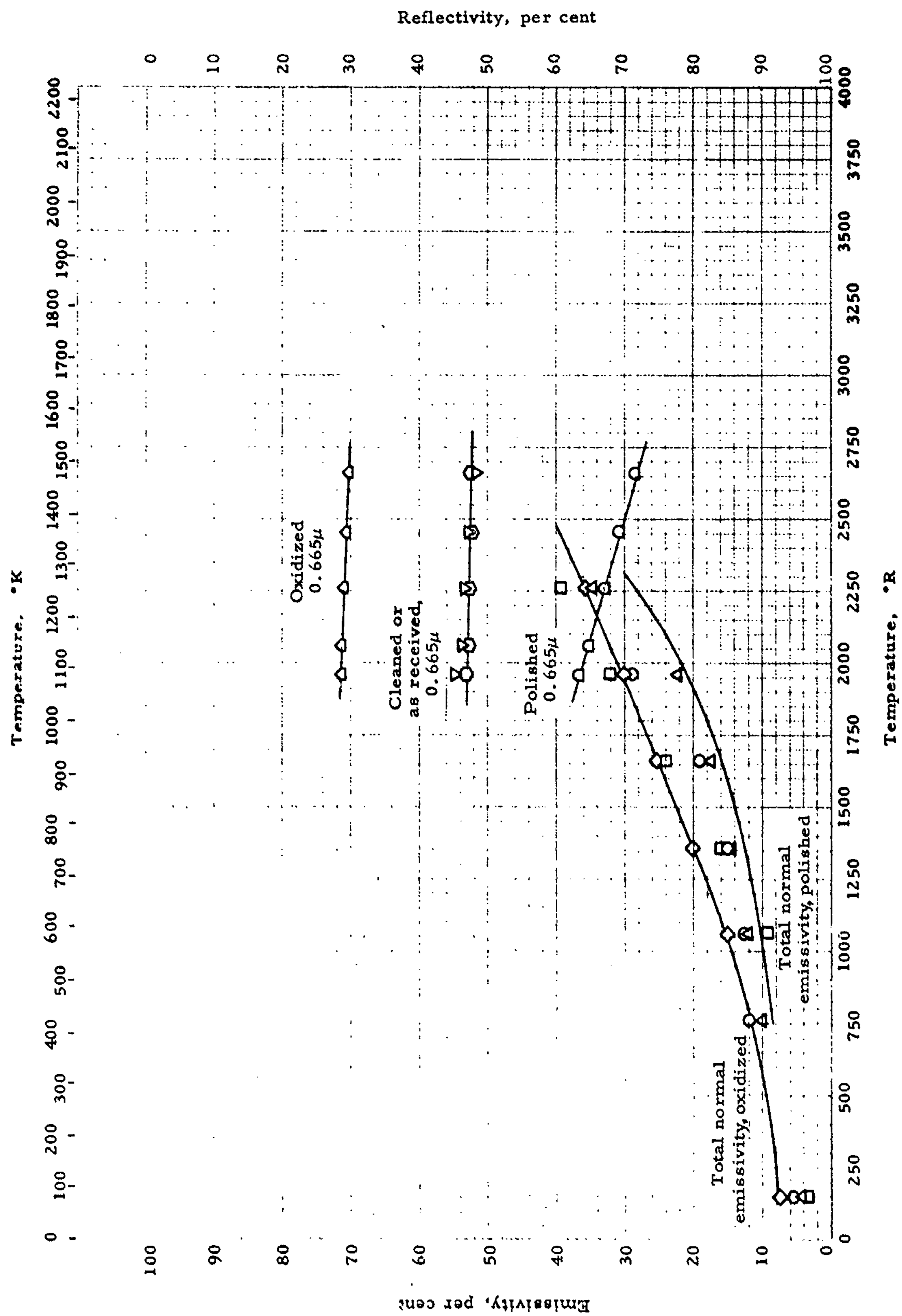


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X
(Alloy N-155)

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X
(Alloy N-155)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H., et al.	57-8	Room	Cobalt Alloy N-155. Nominal: 30.2% Fe; 21% Cr; 20% ea. Ni, Co; 3.0% Mo; 2.5% W; 1.5% Mn; 1.0% Nb; 0.5% Si; 0.15% ea. C, N	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Surface as received
□	Ibid.	57-8	Room	Same as above	Same as above	Cleaned
△	Ibid.	57-8	Room	Same as above	Same as above	Polished
◇	Ibid.	57-8	Room	Same as above	Same as above	Oxidized 30 min. at red heat in air
▽	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Polished
⬡	Ibid.	57-8	1960-2660	Same as above	Same as above	Oxidized 30 min. at red heat in air

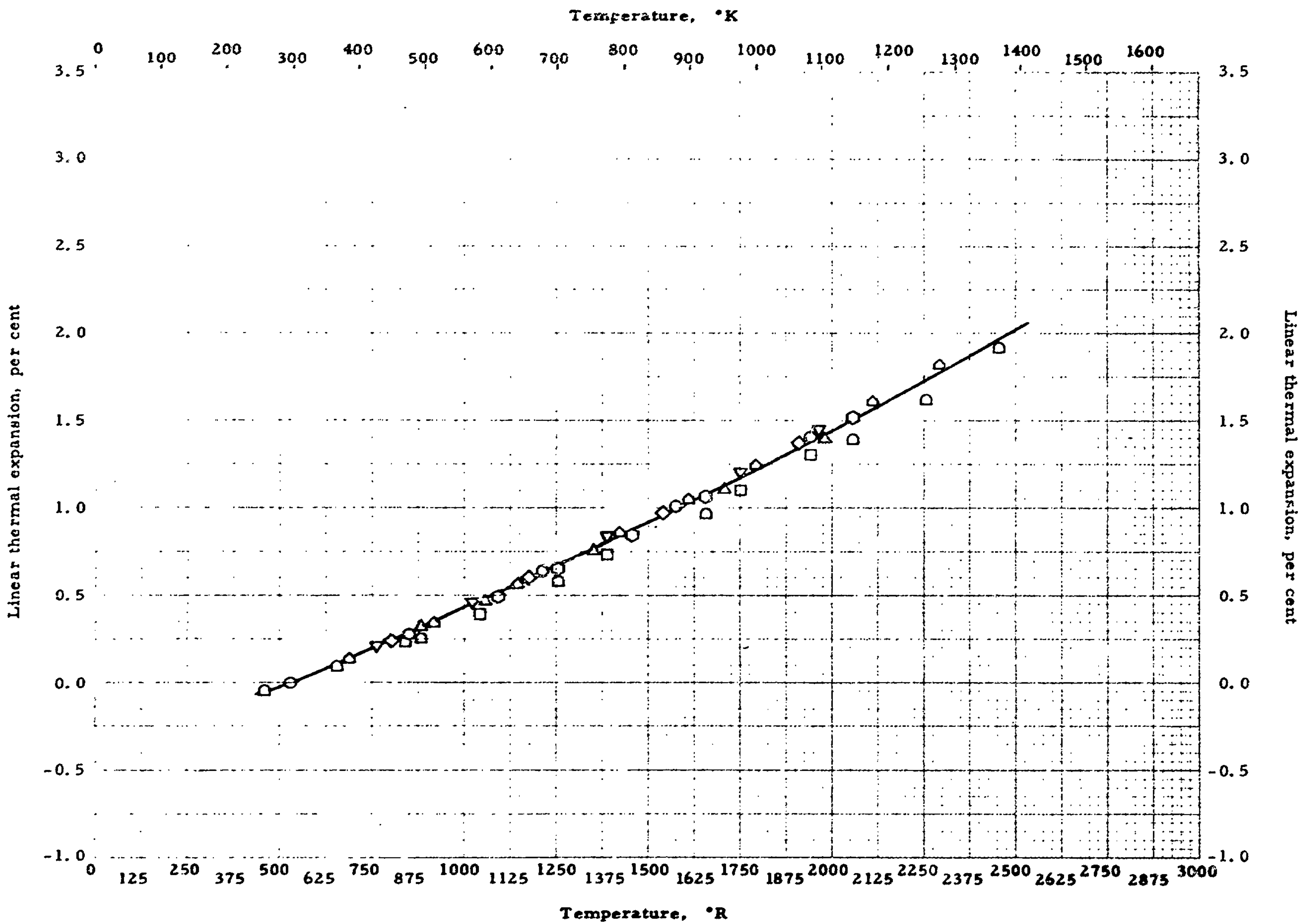


EMISSIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X (Alloy N-155)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X
(Alloy N-155)

REFERENCE INFORMATION

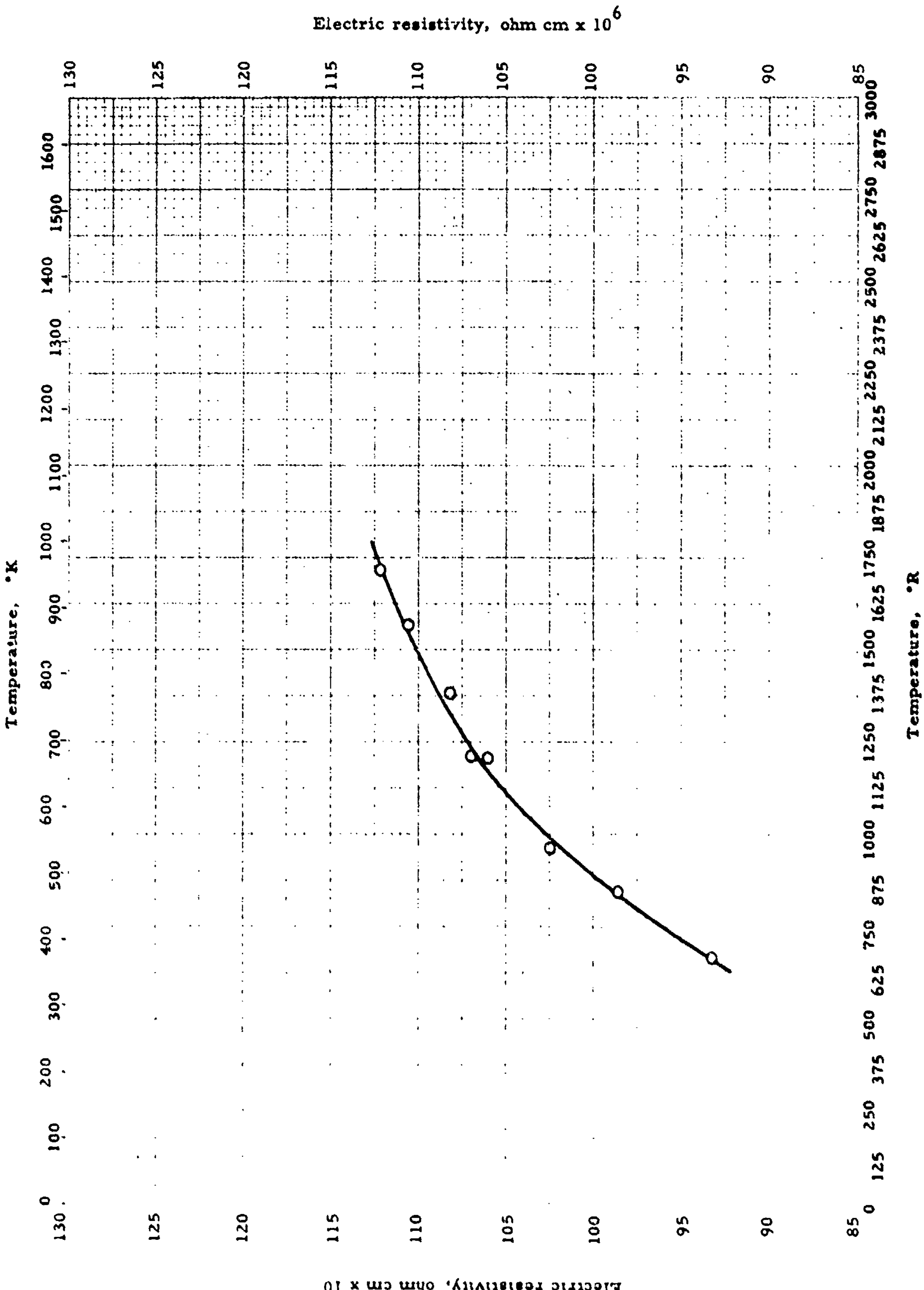
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H., et al.	57-8	150-2260	Cobalt Alloy N-155: nominal: 30% Fe; 21% Cr; 20% ea. Ni, Co; 3% Mo; 2.5% W; 1.5% Mn; 1.0% Nb; 0.5% Si; 0.15% ea. C, N	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	As received
□	Ibid.	57-8	150-2260	Same as above	Same as above	Detergent cleaned
△	Ibid.	57-8	150-2260	Same as above	Same as above	Polished
◇	Ibid.	57-8	150-2260	Same as above	Same as above	Oxidized 30 min. at red heat in air
▽	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	As received
⬡	Ibid.	57-8	1960-2660	Same as above		Detergent cleaned
⌂	Ibid.	57-8	1960-2660	Same as above		Polished
⌂	Ibid.	57-8	1960-2660	Same as above		Oxidized 30 min. at red heat in air



LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + COBALT + X
(13 - 23% Cr; 12 - 21% Ni; 4 - 21% Co)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	852-1932	DVL 46 (German Desig.): 19.2% Cr; 14.2% Ni; 5.2% Co; 4.5% W; 1.5% Si; 0.67% Mn; 0.41% C. ρ = 503 lb_m/ft^3	Dilatometer	Forged
□	Ibid.	47-8	852-1932	DVL 47 (German Desig.): 27.7% Cr; 13.7% Ni; 4.7% Co; 1.5% Si; 0.75% Mn; 0.46% C. ρ = 501 lb_m/ft^3	Same as above	Same as above
△	Ibid.	47-8	852-1932	DVL 48 (German Desig.): 25.8% Cr; 12.7% Ni; 4.95% Co; 3.6% W; 3.3% Si; 0.72% Mn; 0.42% C; 0.28% Ti. ρ = 497 lb_m/ft^3	Same as above	Same as above
◇	Ibid.	47-8	852-1932	DVL 49 (German Desig.): 19.7% Cr; 14.5% Ni; 11.1% Co; 2.98% W; 0.68% Si; 0.56% Mn; 0.44% C. ρ = 504 lb_m/ft^3	Same as above	Same as above
▽	Ibid.	47-8	852-1932	DVL 50 (German Desig.): 20.0% Cr; 14.4% Ni; 6.35% Co; 2.7% V; 1.03% Si; 0.86% Mn; 0.44% C. ρ = 488 lb_m/ft^3	Same as above	Same as above
○	Sweeny, W. D.	50-14 also 47-14	1060-2060	Multimet Alloy NR-21 (AMS-55326): 20.0-22.5% Cr; 19.0 - 21.0% Ni; 18.5 - 21.0% Co; 2.5 - 3.5% Mo; 2.0 - 3.0% W; 0.75 - 1.25% (Nb + Ta); 0.10 - 0.20% N; 0.08% - 0.16% C	Not given	Wrought. Data from Union Carbon and Carbide Co.
⌂	Ibid.	50-14 also 47-14	460-2460	Multimet Alloy Low Carbon NR-21 (AMS-53762): 20.0 - 22.5% Cr; 19.0 - 21.0% Ni; 18.5 - 21.0% Co; 2.5 - 3.5% Mo; 2.0 - 3.0% W; 0.75 - 1.25% (Nb + Ta); 0.10 - 0.20% N; 0.20% C max	Same as above	As cast
⌒	Oliver, D.A. and Harris, M.A.	52-25	672-2292	Jessop G-18B Steel (British Desig.): 13.0% ea. Ni, Cr; 10.0% Co; 3.0% Nb; 2.5% W; 2.0% Mo; 1.0% Si; 0.8% Mn; 0.4% C. ρ = 508 lb_m/ft^3	Not given	



ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Perova, V.I. and Knoroz, L.I.	57-117	670-1720	20% Cr; 20% Ni; 20% Co	Potential drop, temp. by Chromel-Alumel thermocouple	Sample forged, quenched in oil from 1200°C. Aged 70 hr. at 760°C. Auth. est. accuracy ± 1%

PROPERTIES OF IRON + CHROMIUM + NICKEL + X
(16 - 19% Cr; 7 - 16% Ni)

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	495 lb_m/ft^3 *	7.93 g/cm^3 *
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Approx. value for engineering purposes.

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3	Material
○	496.5	7.952	AISI-316
□	493.5	7.905	AISI-347
△	446	7.15	Hot pressed powder AISI-302B
◇	449	7.19	Hot pressed powder AISI-302B
	501.7	8.036	
	500.0	8.009	
	464	7.43	17-7 PH
	493	7.89	AISI-321
▽	483	7.74	17-7 PH
	492.0	7.884	SAS-8
	498.1	7.982	ATS
	493	7.9	
	494	7.92	Jessop R-20
	501	8.03	Jessop G-21
	495.3	7.938	WF 100D
	484.8	7.770	DVL-51
	491.6	7.875	DVL-30
	493.7	7.908	DVL-52

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF IRON + CHROMIUM + NICKEL + X
(16 - 19% Cr; 7 - 16% Ni)

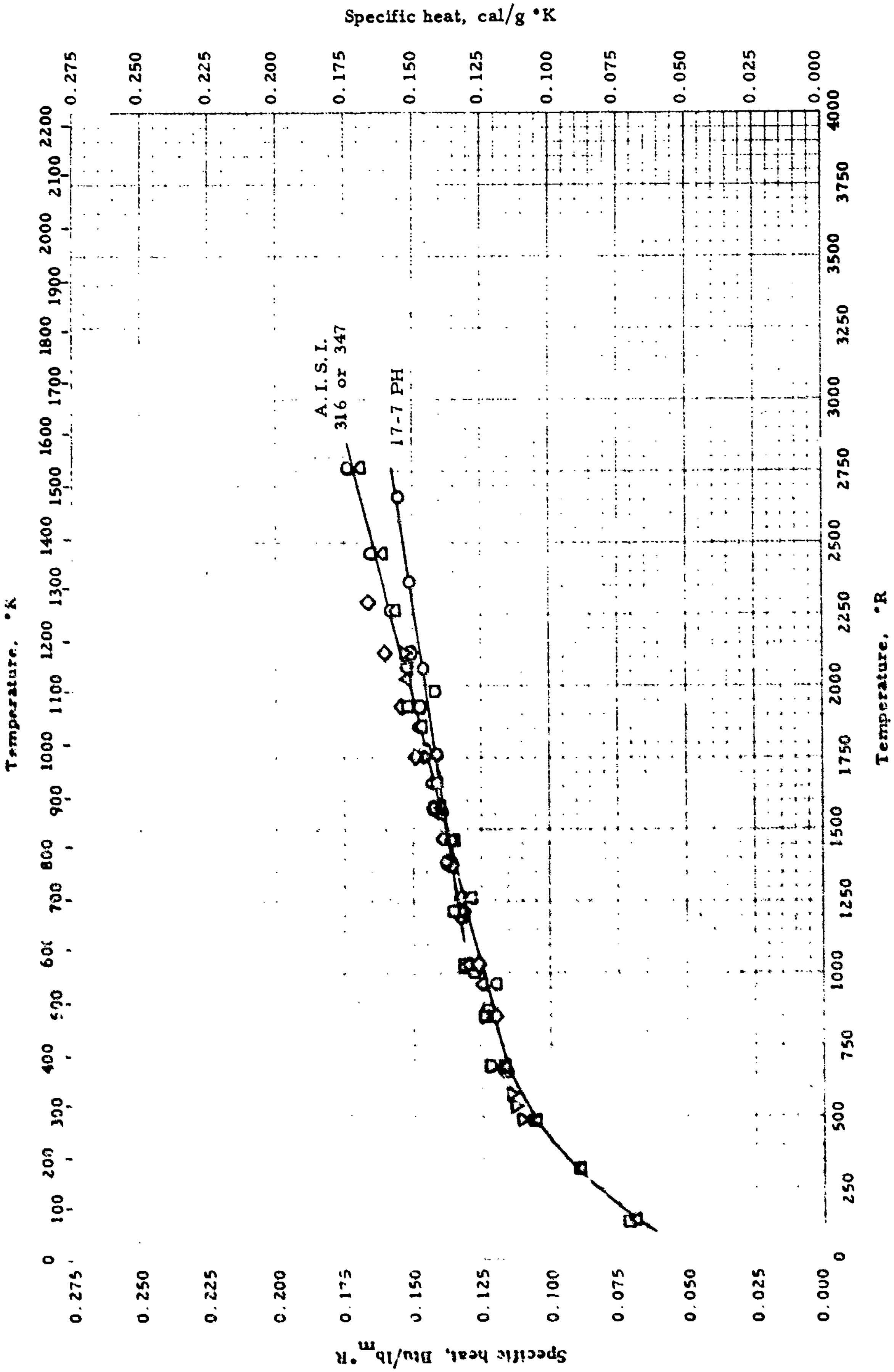
REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5 also 51-65	528	Stainless steel type 316. Nominal: 16 - 18% Cr; 10 - 14% Ni; 2 - 3% Mo	ρ: weight and volume by water displacement	Hot rolled, annealed 1 hr. at 2460 °R, water quenched
□	Ibid.	58-5 51-65	528	Stainless steel type 347. Nominal: 17 - 19% Cr; 9 - 12% Ni, 10 x C = Nb	ρ: same as above	Same as above
△	Trostel Jr., L. J.	55-78	Room	Stainless steel type 302B. Nominal: 17 - 19% Cr; 8 - 10% Ni; 2 - 3% Si; 0.08 - 0.20% C	ρ: weight in air and in water, after boiling 2 hr.	Powder hot pressed at 2110 psi and 2460 °R
◇	Ibid.	55-78	Room	Same as above	ρ: same as above	Powder hot pressed at 2110 psi and 2560 °R
◘	Neimark, B. E.	55-68	Room	15.3% Cr; 12.3% Ni; 2.76% W; 0.72% Mo; 0.59% Si; 0.43% Mn; 0.10% C	ρ: hydrostatic weighing	Austenized. Auth. est. accuracy ± 0.2%
△	Ibid.	55-68	Room	Same as above	ρ: same as above	Stabilized. Auth. est. accuracy ± 0.2%
▢	Seibel, R. D. and Mason, G. L.	57-156	Room	Stainless steel type 17-7 PH: 72.62% Fe (by diff.); 17.08% Cr; 7.21% Ni; 1.19% Al; 0.71% Mn; 0.70% C; 0.45% Si; 0.024% P; 0.017% S	ρ: not given	
▽	Ibid.	57-156	Room	Stainless steel type 321: 69.05% Fe (by diff.); 17.59% Cr; 9.85% Ni; 1.53% Mn; 1.17% Ti; 0.71% Si; 0.091% C; 0.009% S; trace of P	ρ: not given	
▽	Fieldhouse, I. B., Hedge, J. C., et al.	58-4	Room	Stainless steel type 17-7 PH: 72.21% Fe; 17.30% Cr; 7.06% Ni; 1.11% Al; 0.60% Mn; 0.49% Si; 0.074% C	ρ: not given	
○	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	Room	Alloy SAS 8 (German desig.): 62.0% Fe; 17.6% Cr; 15.2% Ni; 2.2% Mo; 1.8% Cu; 1.06% Ta and Nb total; 0.1% C	ρ: not given	
∟	Ibid.	47-8	Room	Alloy ATS (German desig.): 67.3 - 68.6% Fe; 18.0 - 19.3% Cr; 9.2 - 10.3% Ni; 1.35 - 1.75% Ta + Nb total; 0.70 - 0.72% Mn; 0.30 - 0.84% Si; 0.58 - 0.70% W; 0.13 - 0.14% C	ρ: not given	
◇	Ibid.	47-8	Room	WF 100D (German desig.): 14.8% Cr; 12.9% Ni; 2.5% W; 1.84% Si; 0.52% Mn; 0.38% C; 0.23% Mo	ρ: not given	

PROPERTIES OF IRON + CHROMIUM + NICKEL + X (Cont'd)
(16 - 19% Cr; 7 - 16% Ni)

REFERENCE INFORMATION

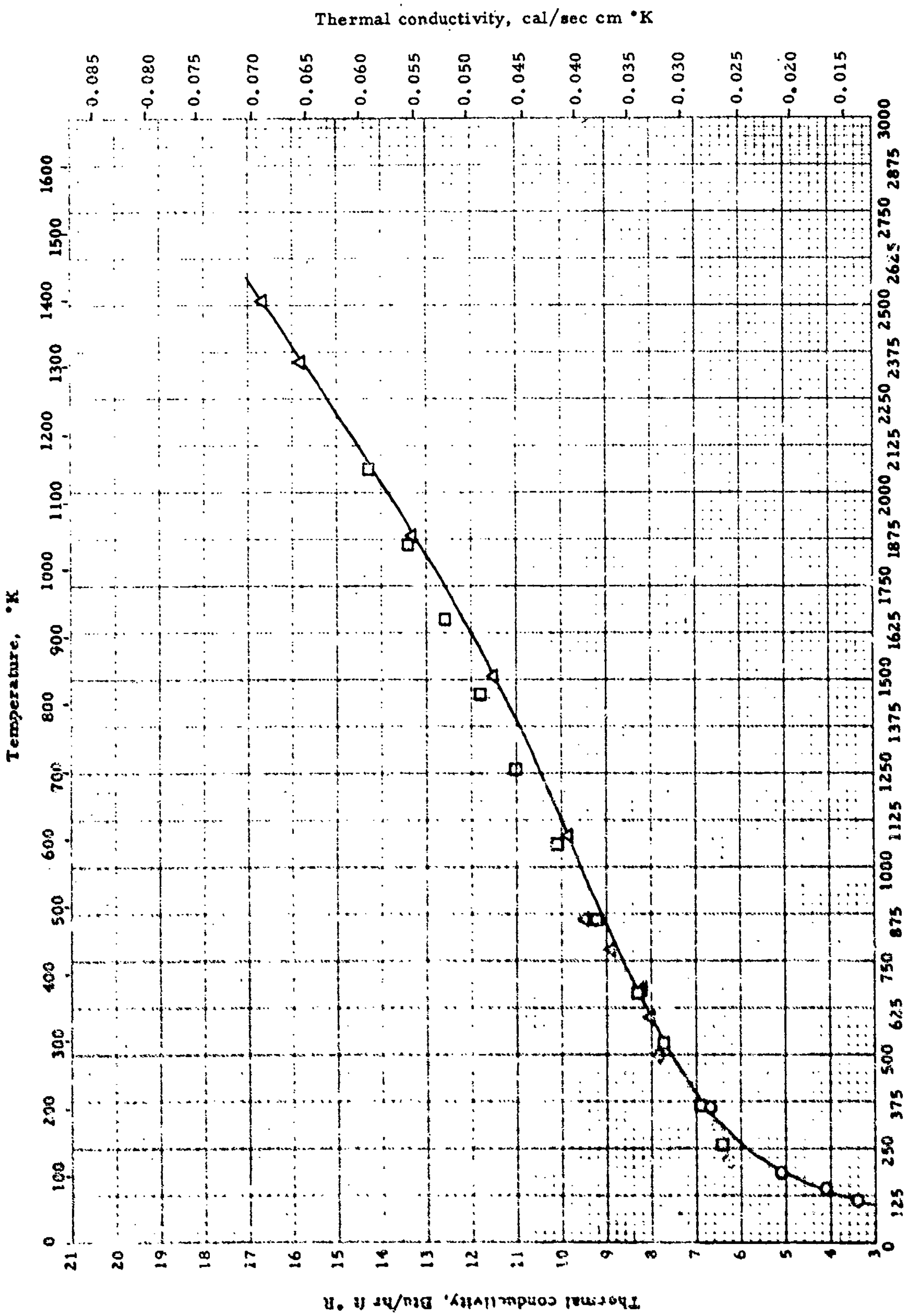
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
◁	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	Room	DVL 51 (German desig.): 16.8% Cr; 12.3% Ni; 1.03% B; 0.88% Si; 0.70% Mn; 0.16% C	ρ: not given	
C	Ibid.	47-8	Room	DVL 30 (German desig.): 21.0% Cr; 14.3% Ni; 3.2% W; 1.61% Mn; 1.60% Si; 1.24% Ti; 0.25% C	ρ: not given	
D	Ibid.	47-8	Room	DVL 52 (German desig.): 21.1% Cr; 15.3% Ni; 3.3% W; 1.84% Mn; 1.57% Si; 0.88% Ti; 0.22% C	ρ: not given	
O	Kirby, H.W. and Sykes, C.	52-27	Room	70.40% Fe (by diff.); 17.84% Cr; 9.5% Ni; 1.22% Nb; 0.50% Si; 0.41% Mn; 0.11% C; 0.014% W; 0.011% S	ρ: not given	
▽	Oliver, D.A. and Harris, M.A.	52-25	Room	Jessop R20 Steel (British desig.): 64.05% Fe (by diff.); 19.0% Cr; 14.0% Ni; 1.7% Nb; 0.80% Mn; 0.30% Si; 0.15% C	ρ: not given	
D	Ibid.	52-25	Room	Jessop G-21 Steel (British desig.): 13.0% ea. Cr, Ni; 1.7% Nb; 0.90% Mn; 0.30% Si; 0.15% C	ρ: not given	



SPECIFIC HEAT -- IRON + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
◔	Fieldhouse, I. B. Hedge, J. C. et al.	58-4	1460-2660	17 - 7 P. H.; before tests: 72.21% Fe; 17.3% Cr; 7.06% Ni; 1.11% Al; 0.60% Mn; 0.49% Si; 0.074% C; after tests 72.71% Fe; 17.35% Cr; 7.13% Ni; 1.09% Al; 0.55% Mn; 0.52% Si; 0.074% C; ρ = 483 lb_m/ft^3	Drop method; liq. calorimeter	Tested in helium atmos.
◻	Lucks, C. F., Matolich, J. and Van Valzor, J. A.	54-27 also 58-5	132-1932	AISI 347. Nominal 17 - 19% Cr; 9 - 12% Ni % Nb = 10 x %C	Drop method; ice calorimeter	
△	Ibid.	58-5	141-2022	AISI 316. Nominal 16 - 18% Cr; 10 - 14% Ni; 2 - 3% Mo, < 2% Mn; <0.1% C	Same as above	
◇	Redmond, R. F. and Lones, J.	52-46	852-2292	AISI 316. 17.0% Cr, 12.2% Ni; 2.3% Mo; 1.49% Mn; 0.55% Si; 0.12% C; 0.026% P; 0.004% S	Drop method; ice calorimeter	Auth. est. accuracy ± 5%
▽	Douglas, T. B. and Dever, J. L.	55-16 also 53-39	492-2112	AISI 347. 18% Cr; 11.1% Ni; 1.30% Mn; 0.86% Nb; 0.52% Si; 0.08% C	Drop method; ice calorimeter	Auth. est. accuracy ± 2%
○	Douglas, T. B. and Victor, A. C.	57-56	672-2112	AISI 316	Drop method; ice calorimeter	
⌂	Fieldhouse, I. B., Hedge, J. C. and Lang, J. I.	58-2	960-2760	AISI 347. Mfg. analysis: 17.82% Cr; 10.32% Ni; 1.62% Mn; 0.6% Si; 0.14% Mo; 0.13% Cu; 0.06% C; 0.018% ea. P, S	Drop method; water calorimeter	
⌂	Ibid.	58-2	960-2760	AISI 316.	Same as above	
◡	Ewing, C. T. and Baker, B. E.	54-65	674-1679	AISI 347. Nominal 17-19% Cr; 9-12% Ni; % Nb = 10 x % C	Drop method; Cu block calorimeter	Authors report enthalpy data. Linear equation fitted by least mean square routine at ARF

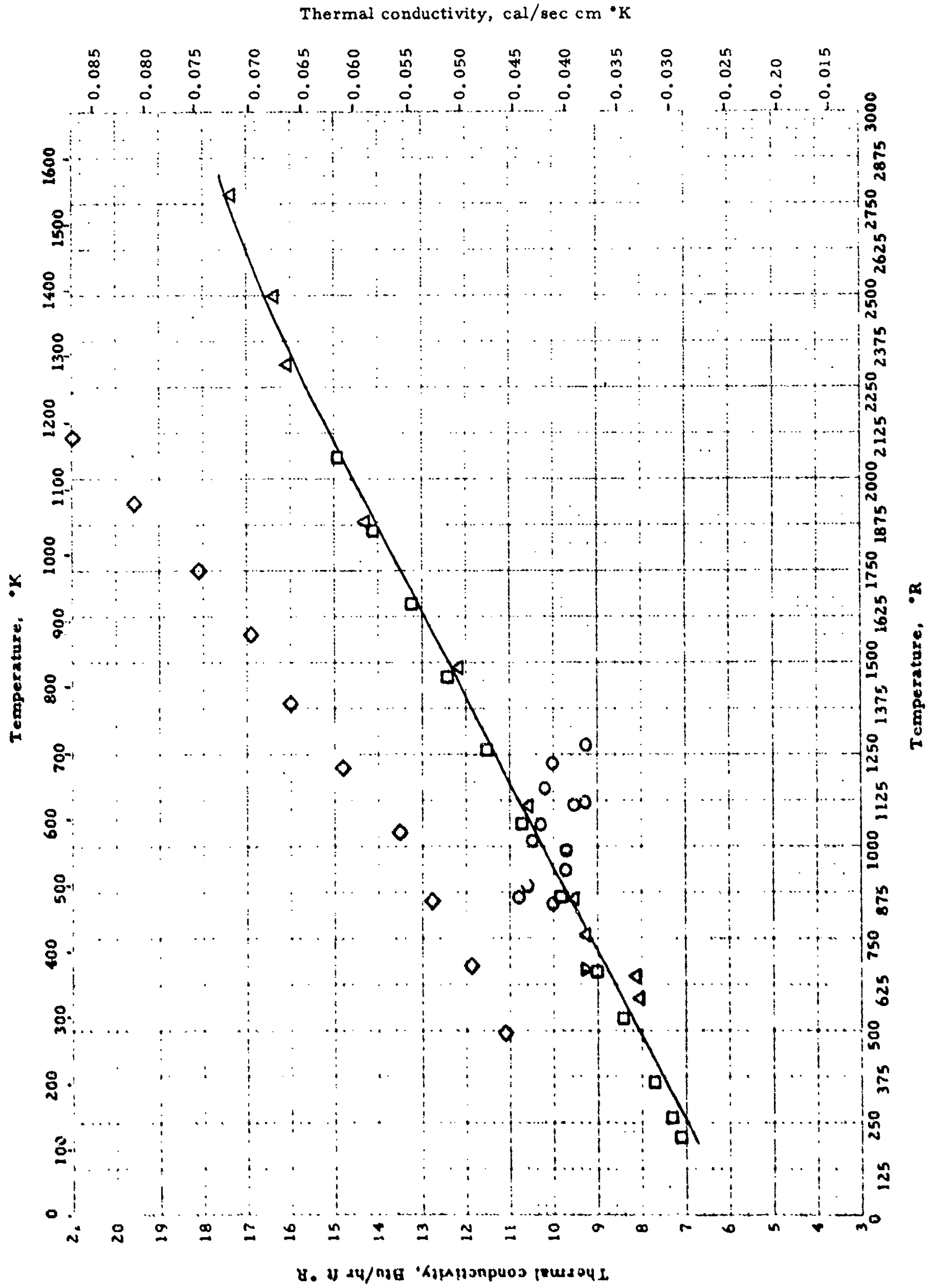


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 316 Stainless Steel)

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 316 Stainless Steel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Tyler, W. W., Nesbitt, L. B. and Wilson Jr., A. C.	53-38 also 52-55	108-540	AISI 316. Nominal: 16 - 18% Cr; 10 - 14% Ni; 2 - 3% Mo	Axial heat flow rod; guarded heat source and sample	25% min. final cold reduction; tested in vacuum; auth. est. accuracy ± 10%
□	Lucks, C. F. and Deem, H. W.	58-5 51-65	210-2260	AISI 316. Nominal compos. Same as above	Comparative; rods (Armco Iron standard)	Hot rolled; annealed 1 hr. at 2000°F; water quenched
△	Fieldhouse, I. B., Hedge, J. C. and Lang, J. I.	58-2	600-2514	AISI 316. Nominal compos. Same as above.	Radial heat flow in cylinder of stacked disks	

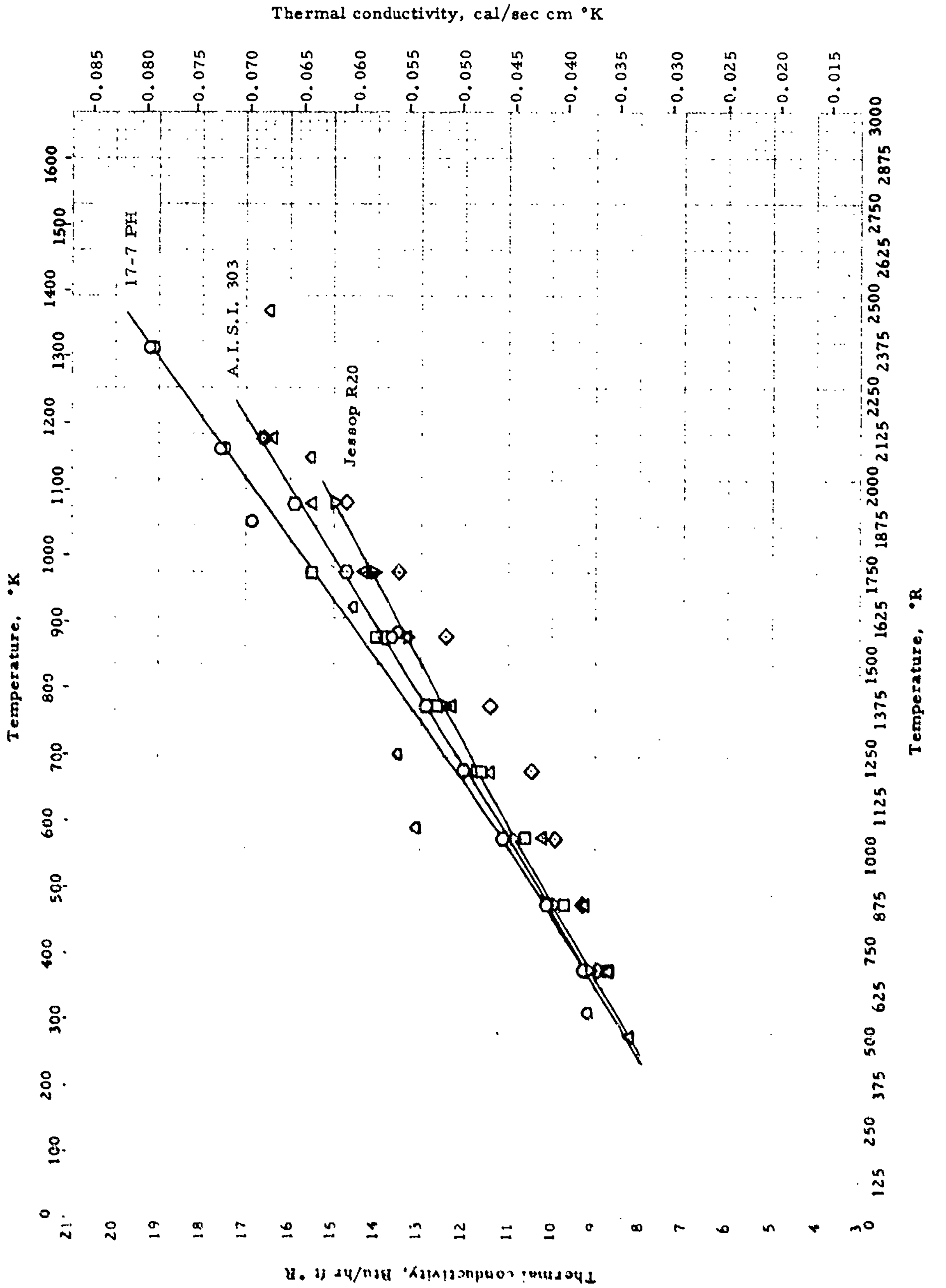


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 347 Stainless Steel)

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 347 Stainless Steel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Vianey, L. R.	51-27	845-1278	AISI 347, 18.00% Cr; 11.12% Ni; 1.77% Mn; 0.88% Nb; 0.07% C; 0.016% P; 0.007% S	Axial heat flow in rod; guarded sample; calorimeter sink	
□	Lucks, C. F. and Deem, H. W.	58-5 51-65	210-2050	AISI 347 Nominal: 17 - 19% Cr; 9 - 12% Ni; 1% Nb	Comparative; rods (Armco Iron standard)	Hot rolled, annealed 1 hr. at 2000 °F; water quenched
△	Fieldhouse, I. B., Hedge, J. C. and Lang, J. I.	58-2	593-2778	AISI 347. Mfg. analysis: 17.82% Cr; 10.32% Ni; 1.62% Mn; 0.6% Si; 0.14% Mo; 0.13% Cu; 0.06% C; 0.018% ea. P, S	Radial heat flow in cylinder of stacked disks	
◇	Hogan, C. L. and Sawyer, R. B.	52-75	492-2112	AISI 347, 18.00% Cr; 11.20 Ni; 1.80% Mn; 0.77% Nb; 0.70% Si; 0.069% C; 0.021% P; 0.007% S	Temp. distribution in rod heated at one end; meas. heat loss from surface	
▽	Smith, K. F. and Chiswik, H. H.	56-113	671	AISI 347 Nominal: 17-19% Cr; 9-12% Ni; 1% Nb	Comparative apparatus heated by NaK bath	

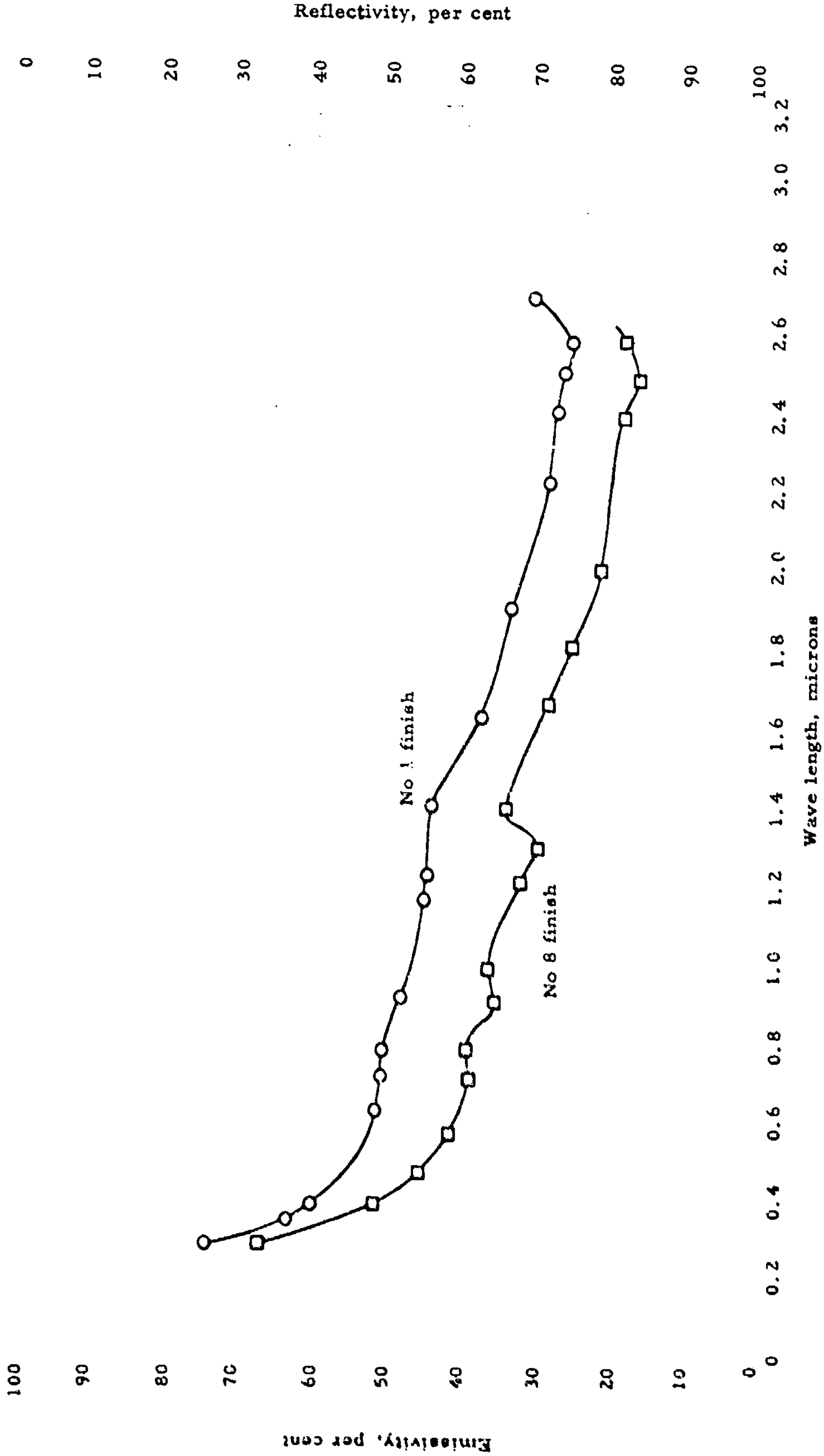


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I. B. Hedge, J. C. et al.	58-4	1578-2357	17-7 P.H. stainless. Before test: 72.21% Fe; 17.30% Cr; 7.06% Ni; 1.11% Al, 0.60% Mn; 0.49% Si; 0.074% C. After test: 72.71% Fe; 17.35% Cr; 7.13% Ni; 1.09% Al; 0.55% Mn; 0.52% Si; 0.074% C; ρ = 483 lb_m/ft^3	Single flat plate, boiling liquid calorimeter	Tested in He atmos.
□	Oliver, D. A., and Harris, M. A.	52-25	528-1752	Jessop R20 steel (Brit. Desig.); 19.0% Cr; 14% Ni; 1.7% Nb; 0.80% Mn; 0.30% Si; 0.15% C; ρ = 494 lb_m/ft^3	Not given	
△	Hogan, C. L., and Sawyer, R. B.	52-[illegible]5	492-2112	AISI 303 stainless. 18.42% Cr; 8.97% Ni; 0.61% Mn; 0.51% Si; 0.17% C	Temp. distribution in rod heated at one end; meas. heat loss from surface	
◇	Neima[illegible], B. E.	55-68	672-2112	15.3% Cr; 12.3% Ni; 2.76% W; 0.72% Mo; 0.59% Si; 0.43% Mn; 0.10% C	Temp. distribution in electrically heated rod	Austenitized
▽	Ibid.	55-68	672-2112	Same as above	Same as above	Stabilized 10 hr. at 800°C
○	Ibid.	55-68	672-2112	16.1% Cr; 9.82% Ni; 0.88% Mn; 0.74% Si; 0.45% Ti; 0.09% C	Same as above	
◇	Seibel, R. D. and Mason, G. L.	57-156	1060-2460	Stainless Steel Type 17-7 PH. 72.62% Fe; 17.00% Cr; 7.21% Ni; 1.19% Al; 0.71% Mn; 0.70% C; 0.45% Si; 0.024% P; 0.017% S	Comparative, rods	Ni standard. Tested in vacuum. ρ = 464 lb_m/ft^3. Auth. est. accuracy ±20%
○	Stuckes, A. D. and Chasmar, R. P.	57-130	564	Stainless Steel Type 18-8. No composition given	Comparative, rods in vacuum	Fe standard. Contact resistance reduced by In amalgam

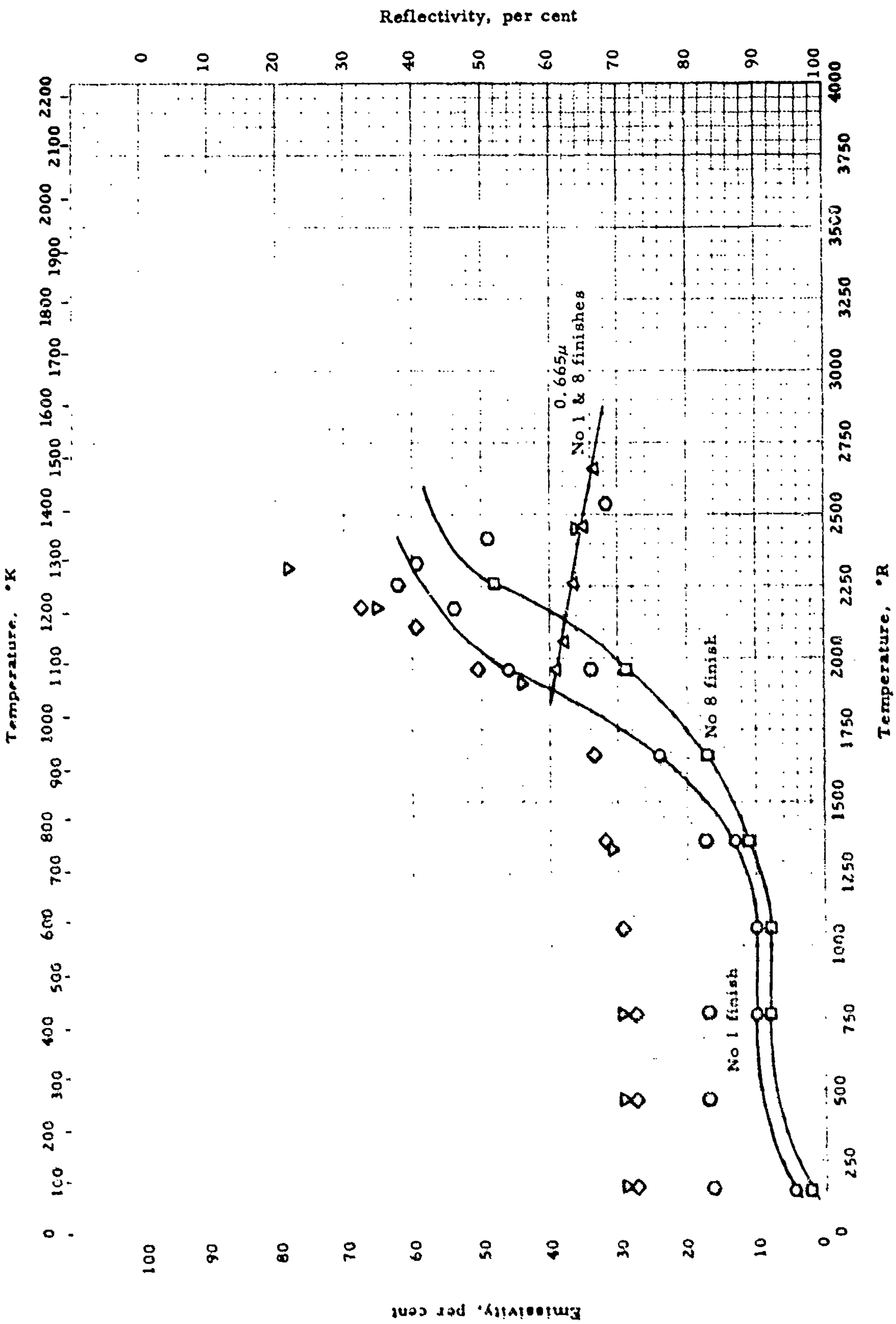


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(A.I.S.I. 316)

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(A.I.S.I. 316)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H., et al.	57-8	Room	Stainless Steel 316. Nominal: 16.00-18.00% Cr; 10.0-14.0% Ni; 2.0-3.0% Mo; <2.00% Mn; <1.00% Si; <0.08% C	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS

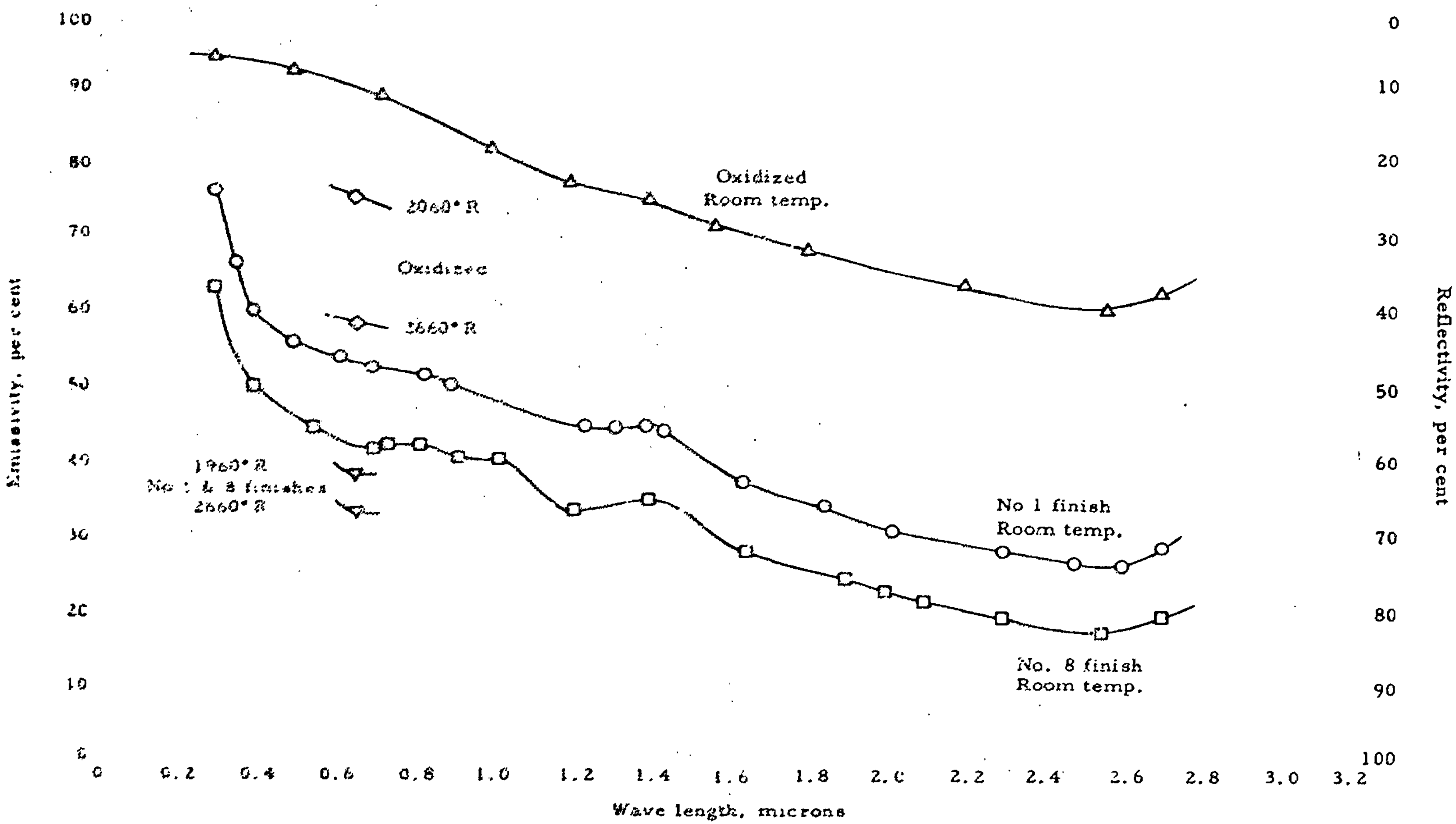


EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(A.I.S.I. 316)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X (A.I.S.I. 316)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H. et al.	57-8	150-1960	Stainless Steel 316: 16 - 18% Cr; 10 - 14% Ni; 2 - 3% Mo; <0.10% C; Grade MIL-S-5059 A, annealed condition	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	150-2260	Same as above	Same as above	Finish No. 8, 2 microinch RMS
△	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer, sample temp. by thermocouple	Finish No. 1 and 8, 2 - 15 microinch RMS
◇	Wilkes, G.B.	54-122	160-2550	AISI 316 Stainless Steel: Nominal: 16 - 18% Cr; 10 - 14% Ni; 2 - 3% Mo	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, in He atm. of 10μ of Hg. Temp. by Chromel-Alumel and Cu-Const. thermocouples	Auth. also reports data for cooling and 2nd heating cycle as received: surface cleaned with toluene and alcohol
▽	Ibid.	54-122	160-2550	Same as above	Same as above	Auth. also reports data for 2 other heating and cooling cycles. Clean and smooth: scrubbed with Bon Ami, then cleaned with water, toluene and alcohol
○	Ibid.	54-122	160-2550	Same as above	Same as above	Auth. also reports data for 2 cooling and 1 heating cycles. Polished: buffed until mirror-like and washed with soap

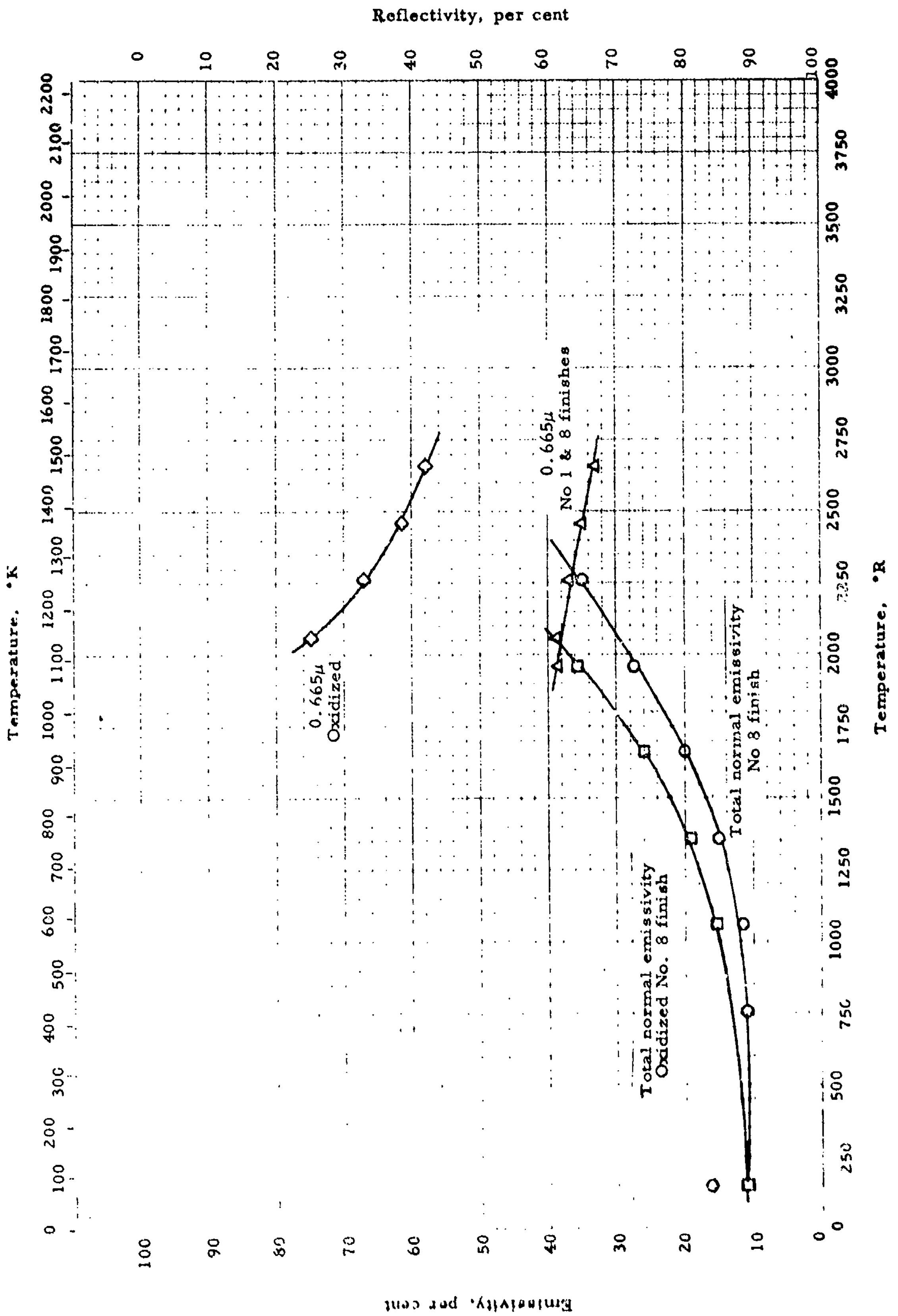


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(AM-350)

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(AM-350)

REFERENCE INFORMATION

Sym-bol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., and Olson, O.H., et al.	57-8	Room	Stainless Steel AM-350. Nominal 16.5-17.5% Cr, 4.0-4.5% Ni, 2.5-3.0% Mo; 0.5-0.75% Mn; 0.2-0.5% Si, 0.1% C. Aircraft grade. Subzero cooled and tempered	Spectral reflectivity at 9°; sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 1, 15 microinch RMS
□	Ibid	57-6	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS
▽	Ibid	5[illegible]-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ; comparative; surface brightness compared with that of a black body hole, disappearing filament optical pyrometer, sample temp. by thermocouple	Finish No. 1 and 8
◇	Ibid.	57-8	2030-2360	Same as above	Same as above	Finish No. 8, 2 microinch RMS, oxidized 30 min. at red heat in air
△	Olson, O.H., and Morris, J.C.	58-1	Room	Same as above	Same as above	Oxidized 30 min. at red heat in air

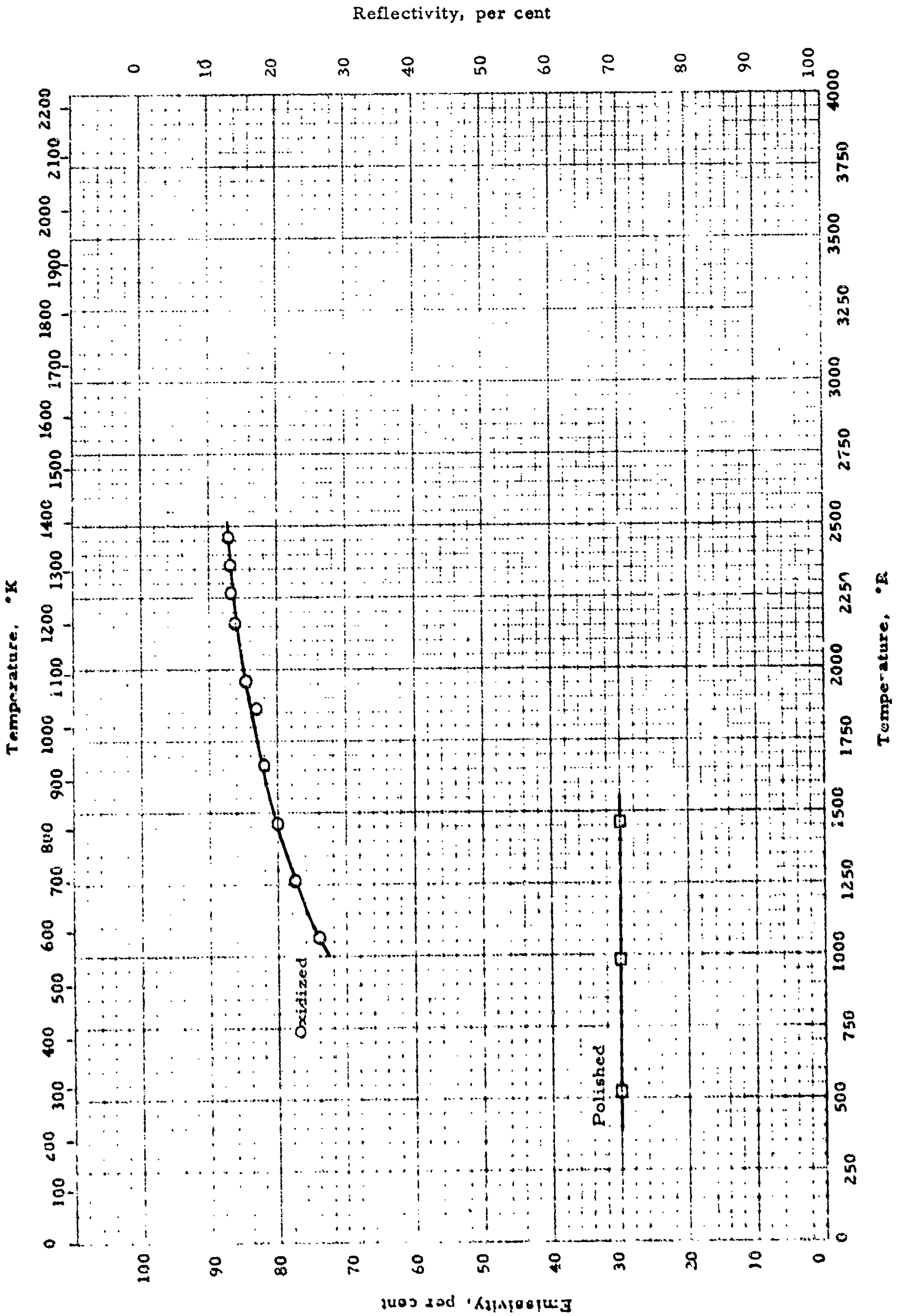


EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(AM 350)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + MOLYBDENUM + X
(AM 350)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., and Olson, O. H., et al.	57-8	150-2260	Stainless Steel AM 350. Nominal: 1[illegible].5-17.5% Cr, 4.0-4.5% Ni; 2.5-3.0% Mo; 0.5-0.75% Mn; 0.2-0.5% Si; 0.10% C. Aircraft grade. Subzero cooled and tempered	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Surface finish No. 8, 2 microinch RMS
□	Ibid.	57-8	150-2260	Same as above	Same as above	Surface finish No. 8, 2 microinch RMS. Oxidized 30 min. at red heat in air
△	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Surface finish No. 1 and 8, 2 and 15 microinch RMS
◇	Ibid.	57-8	1960-2660	Same as above	Same as above	Surface finish No. 9, 2 microinch RMS. Oxidized 30 min. at red heat in air.

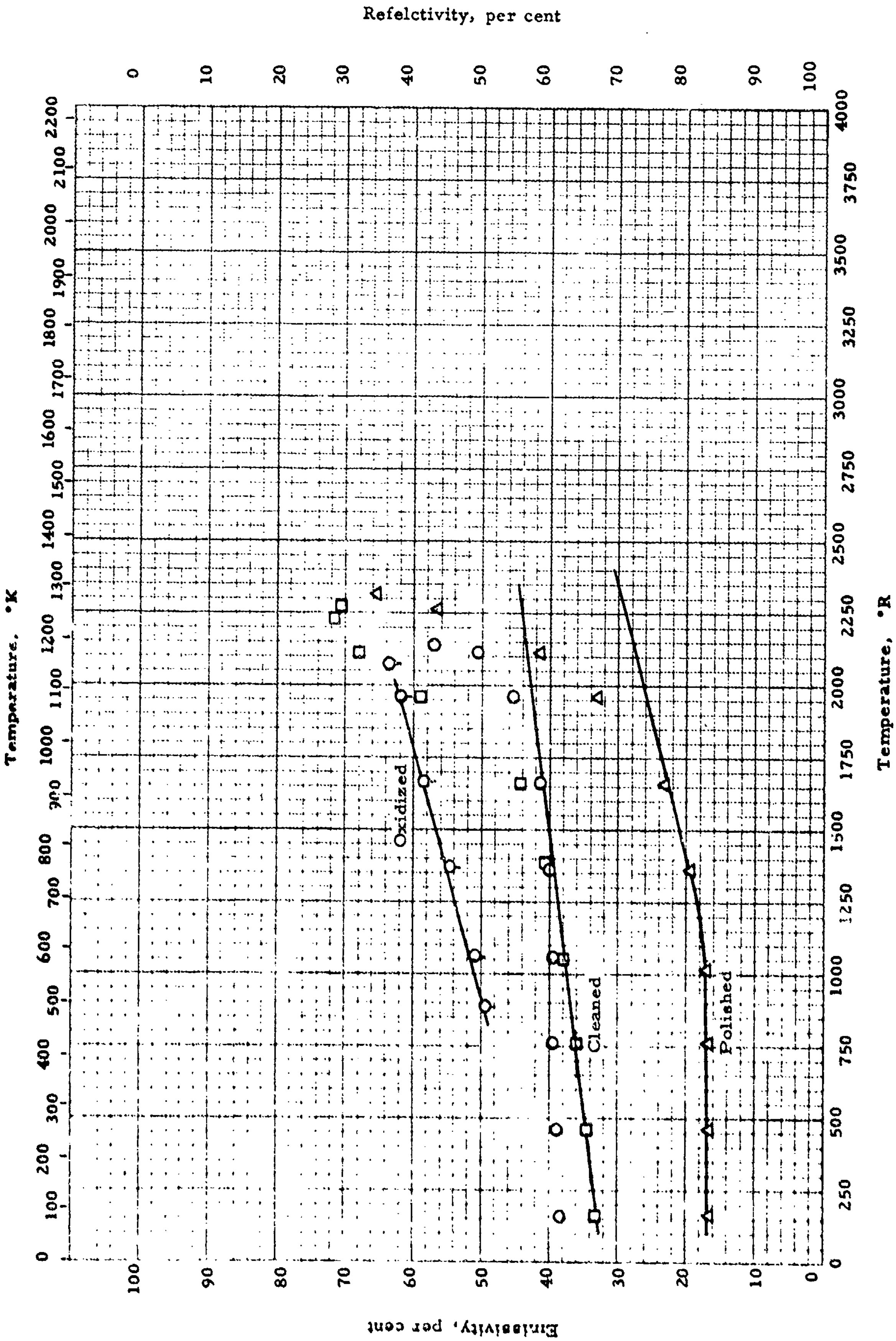


EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 303)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(AISI 303)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
O	Wade, W. R.	59-20	1060-2460	AISI 303 - Stainless steel. Nominal: 17-19% Cr; 8-10% Ni; >0.07% ea P, S, Se	Total normal and hemispherical emissivity: Radient heat measured with thermopile calibrated with a black body.	Oxidized 1 hour at 2000°F after polishing. Author concludes that hemispherical = normal emissivity here.
□	Ibid	56-20	Room - 1460	Same as above	Same as above	Polished. Author concludes that hemispherical = normal emissivity here.

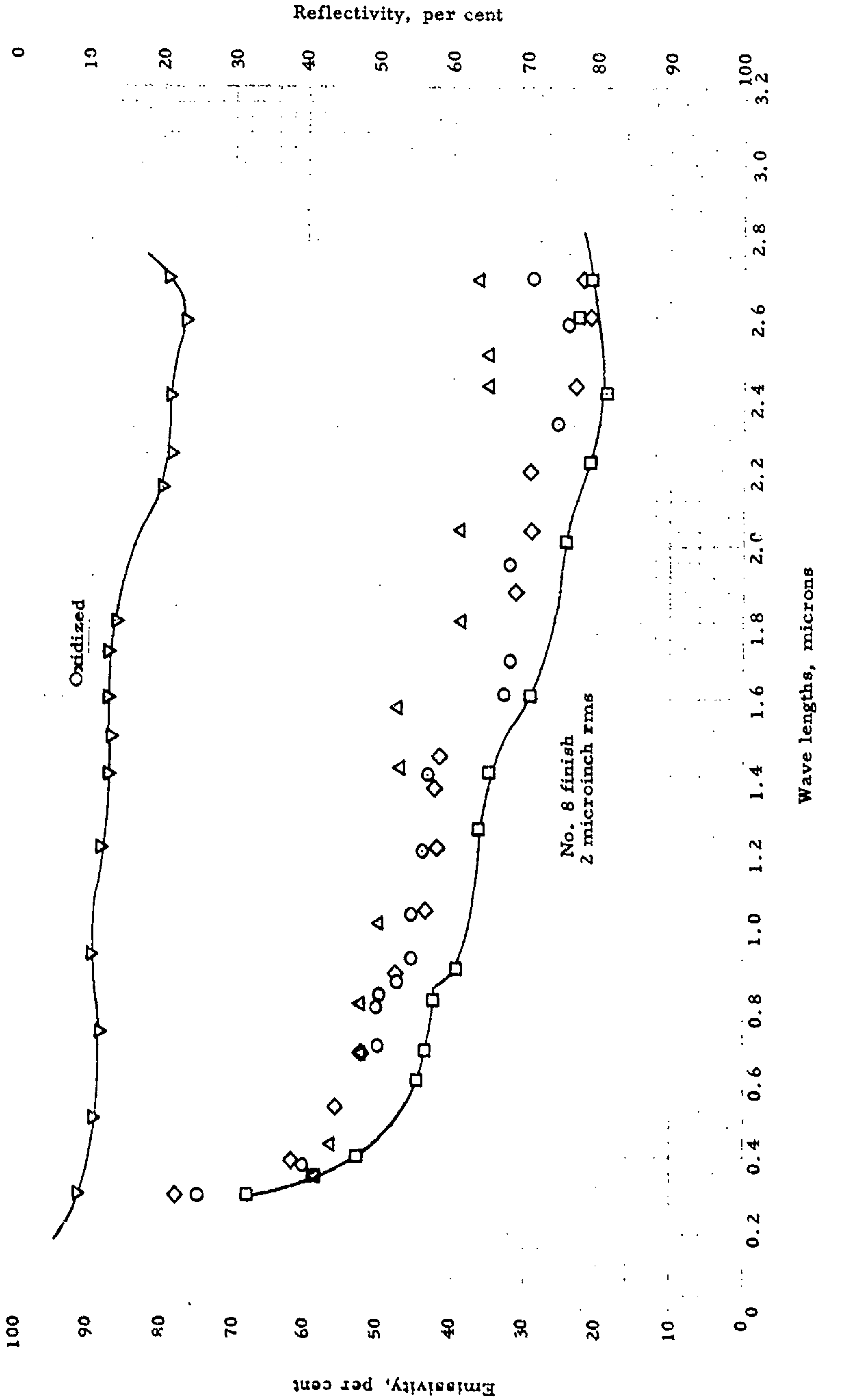


EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
AISI 347

EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
AISI 347

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G.B.	54-122	160-2140	AISI 347 Stainless Steel; nominal: 17-19% Cr; 9 - 12% Ni; % Nb = 10 times % C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body	As received, wiped with toluene until clean; then with methyl alcohol ○ - heating ⚲ - cooling
□	Ibid.	54-122	160-2270	Same as above	Same as above	Cleaned and smoothed sample: scrubbed with Bon Ami, washed with water and dried; wiped with toluene and then alcohol
△	Ibid.	54-122	160-2320	Same as above	Same as above	Polished: buffed until mirror-like and free of scratches, washed with soap and dried

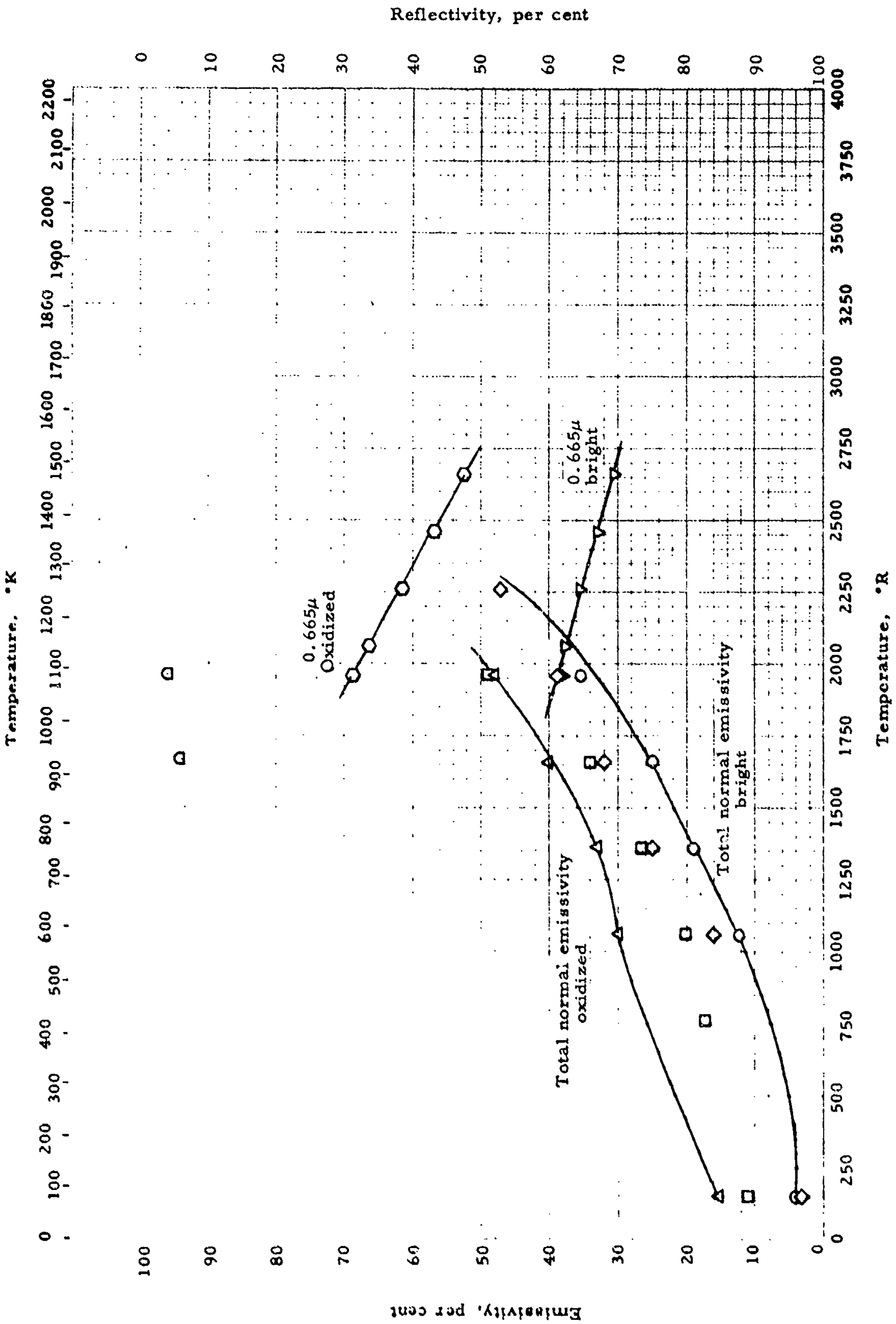


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(A.I.S.I. 321)

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + X (A.I.S.I. 321)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H., et al.	57-8	Room	Nominal: 17-19% Cr; 9.0-12% Ni; 2.00% Mn max; 1.00% Si max; 0.08 C max, min Ti = 5 x C. Grade MIL-S-6721A	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	No. 1 finish, 15 microinch rms
□	Ibid.	57-8	Room	Same as above	Same as above	No. 8 finish, 2 microinch rms
△	Ibid.	57-8	Room	Same as above	Same as above	No. 2D finish, 6 microinch rms
◇	Ibid.	57-8	Room	Same as above	Same as above	No. 2 bright finish
▽	Olson, O.H., and Morris, J.C.	58-1	Room	Not given	Same as above	Surface oxidized 30 min. at red heat in air

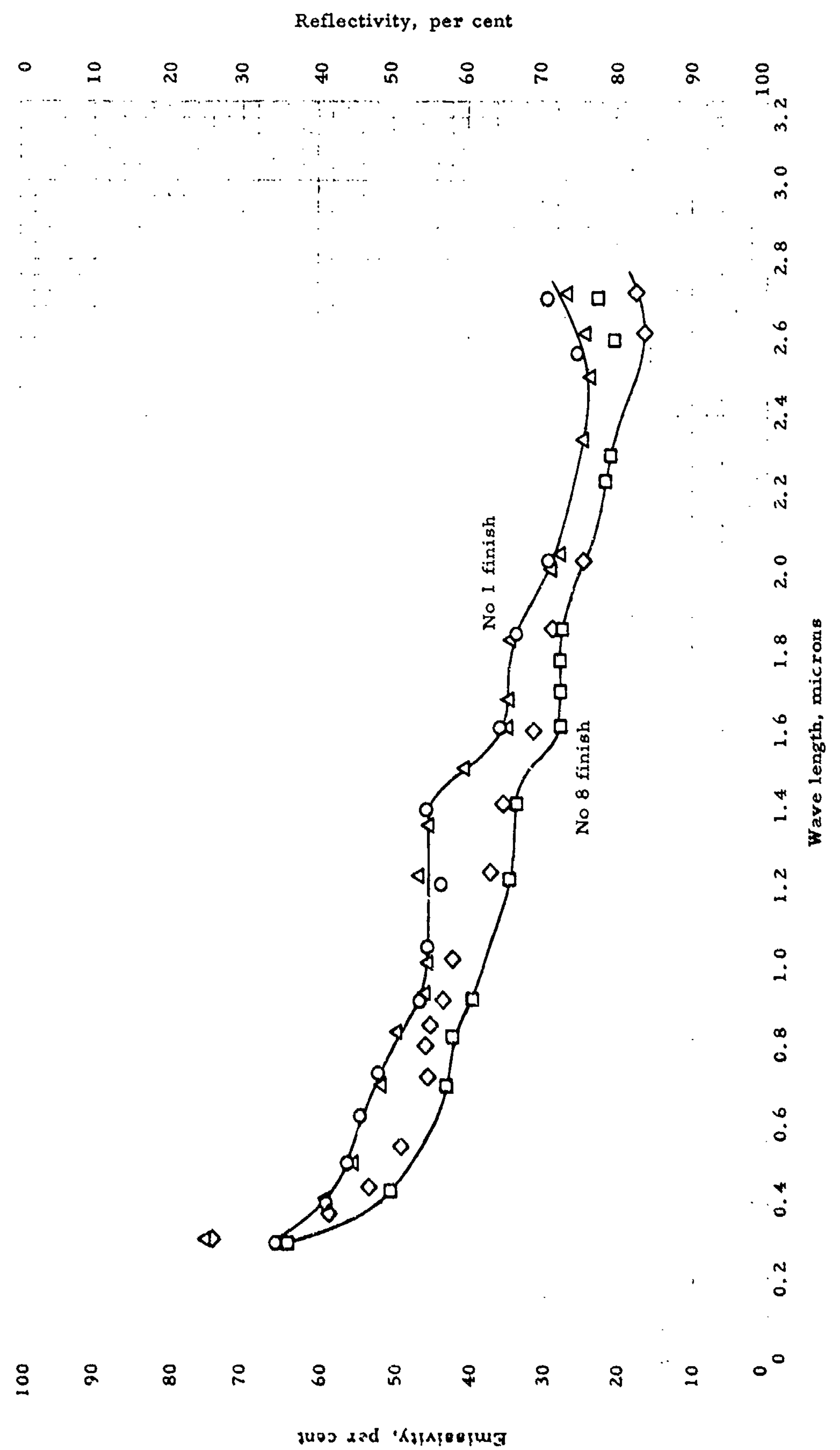


EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(A.I.S.I. 321)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(A.I.S.I. 321)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H. et al.	57-8	150-1960	Stainless Steel 321. Nominal: 17-19% Cr; 9-12% Ni; < 2% Mn; < 1% Si; < 0.08% C; %Ti > 5(%C); Grade MIL-S-6721A, annealed	Total normal emissivity: comparative: radiant heat flow compared with that of a black body; thermistor bolometer	Finish No. 2 Bright
□	Ibid.	57-8	150-1960	Same as above	Same as above	Finish 2 Dull, 6 microinch RMS
△	Ibid.	57-8	150-1960	Same as above	Same as above	Finish 2 Dull, 6 microinch RMS. Oxidized 30 min. at red heat in air
◇	Ibid.	57-8	150-1960	Same as above	Same as above	Finish No. 8, 2 microinch RMS
▽	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Same value for 3 finishes No. 2 Bright, No. 2 Dull and No. 8
○	Ibid.	57-8	150-1960	Same as above	Same as above	Finish No. 2 Dull, 6 microinch RMS. Oxidized 30 min. at red heat in air
⌂	Hale, J.C. and Douglas, E.A.	55-126	1660-1960	Stainless Steel 321. Nominal: 17-19% Cr; 9-12% Ni; <2% Mn; <1% Si; <0.08% C; % Ti > 5(% C)	Total normal emissivity: not described here, refers to others	Oxidized at 1800 °F for 15 min.

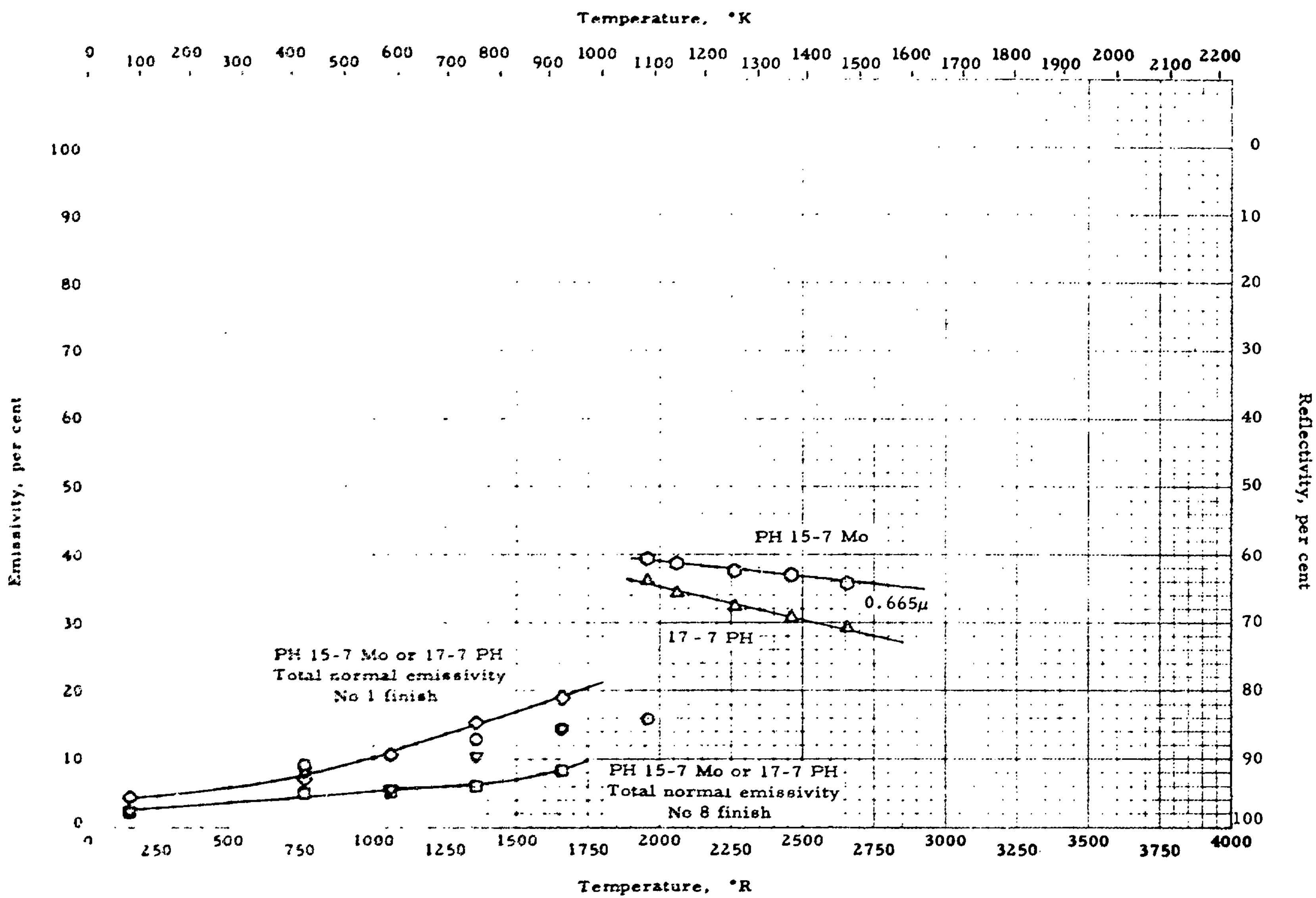


SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(PH Stainless Steels)

SPECTRAL EMISSIVITY -- IRON + CHROMIUM + NICKEL + X (PH Stainless Steels)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., and Olson, O. H., et al.	57-8	Room	Stainless Steel 17-7 PH; nominal: 16-18% Cr; 6.5-7.75% Ni, 0.75-1.25% Al; < 1.00% ea. Mn, Si; < 0.09% C	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS
△	Ibid.	57-8	Room	Stainless Steel PH 15-7 Mo; nominal: 14-16% Cr; 6.5-7.75% Ni; 2-3% Mo; 0.75-1.5% Al; <1% ea. Si, Mn; <0.09% C	Same as above	Finish No. 1, 15 microinch RMS
◇	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS

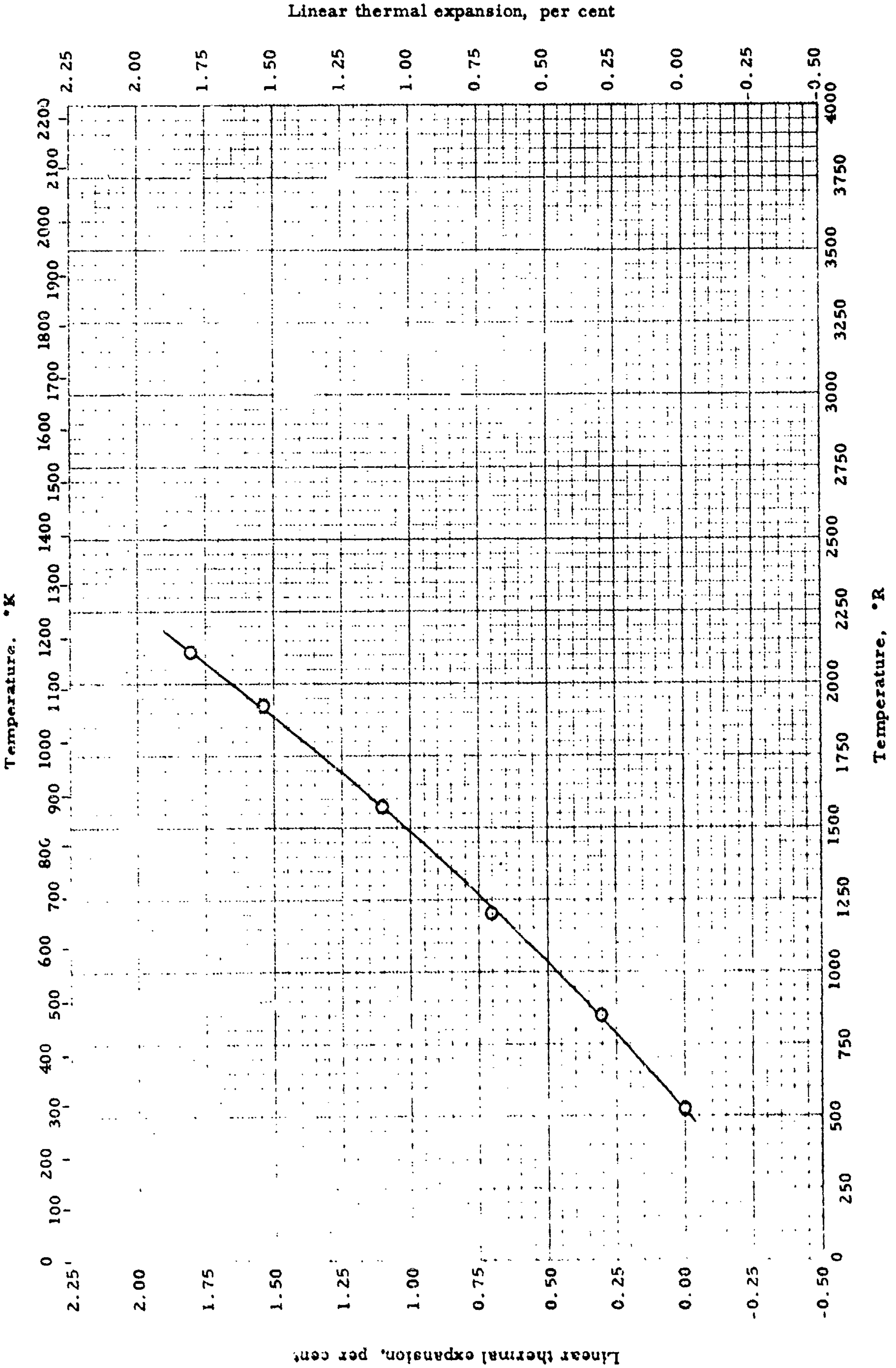


EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(PH Stainless Steels)

EMISSIVITY -- IRON + CHROMIUM + NICKEL + X
(PH Stainless Steels)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H., et al.	[illegible]	160-1960	Stainless Steel 17-7 PH. Nominal 16-18% Cr, 6.5-7.75% Ni, 0.25-1.25% Al, <1.00% ea. Mn, Si, <0.09% C	Total normal emissivity: comparative; radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS RH 950 condition
□	Ibid	[illegible]	160-1960	Same as above	Same as above	Finish No. 8, 2 microinch RMS. RH 950 condition
△	Ibid	[illegible]	1960-2660	Same as above	Spectral normal emissivity at 0.665µ: comparative; surface brightness compared with that of a black body hole, disappearing filament optical pyrometer, sample temp. by thermocouple	Finish No. 1 and 8. RH 950 condition
◇	Ibid	[illegible]	160-1960	Stainless Steel PH 15-7 Mo. Nominal 14-16% Cr, 6.5-7.75% Ni, 2-3% Mo, 0.75-1.5% Al, 1% ea. Si, Mn, <0.09% C	Total normal emissivity: comparative; radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS. RH 950 condition
▽	Ibid	[illegible]	160-1960	Same as above	Same as above	Finish No. 8, 2 microinch RMS. RH 950 condition
⬡	Ibid	[illegible]	1960-2660	Same as above	Spectral normal emissivity at 0.665µ: comparative; surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Finish No. 1 and 8. RH 950 condition

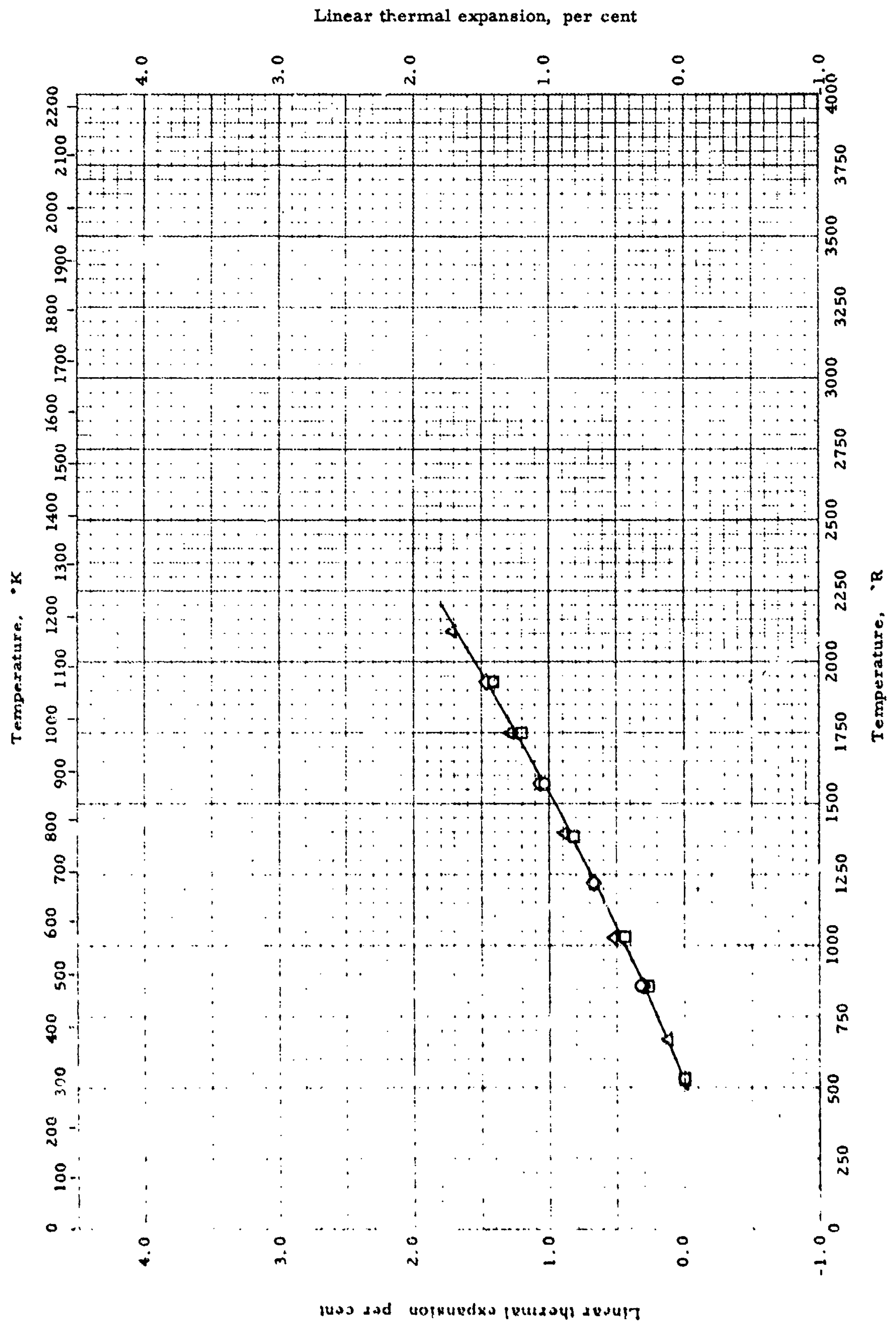


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + MANGANESE + X

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + MANGANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H.	43-17	528-2116	Austenitic steel. 11.8% Cr; 6.0% ea. Ni, Mn; 3.4% Si; 1.2% W; 0.43% C; 0.03% N_2	Bollenrath dilatometer	Heating rate 1.5°C/min.

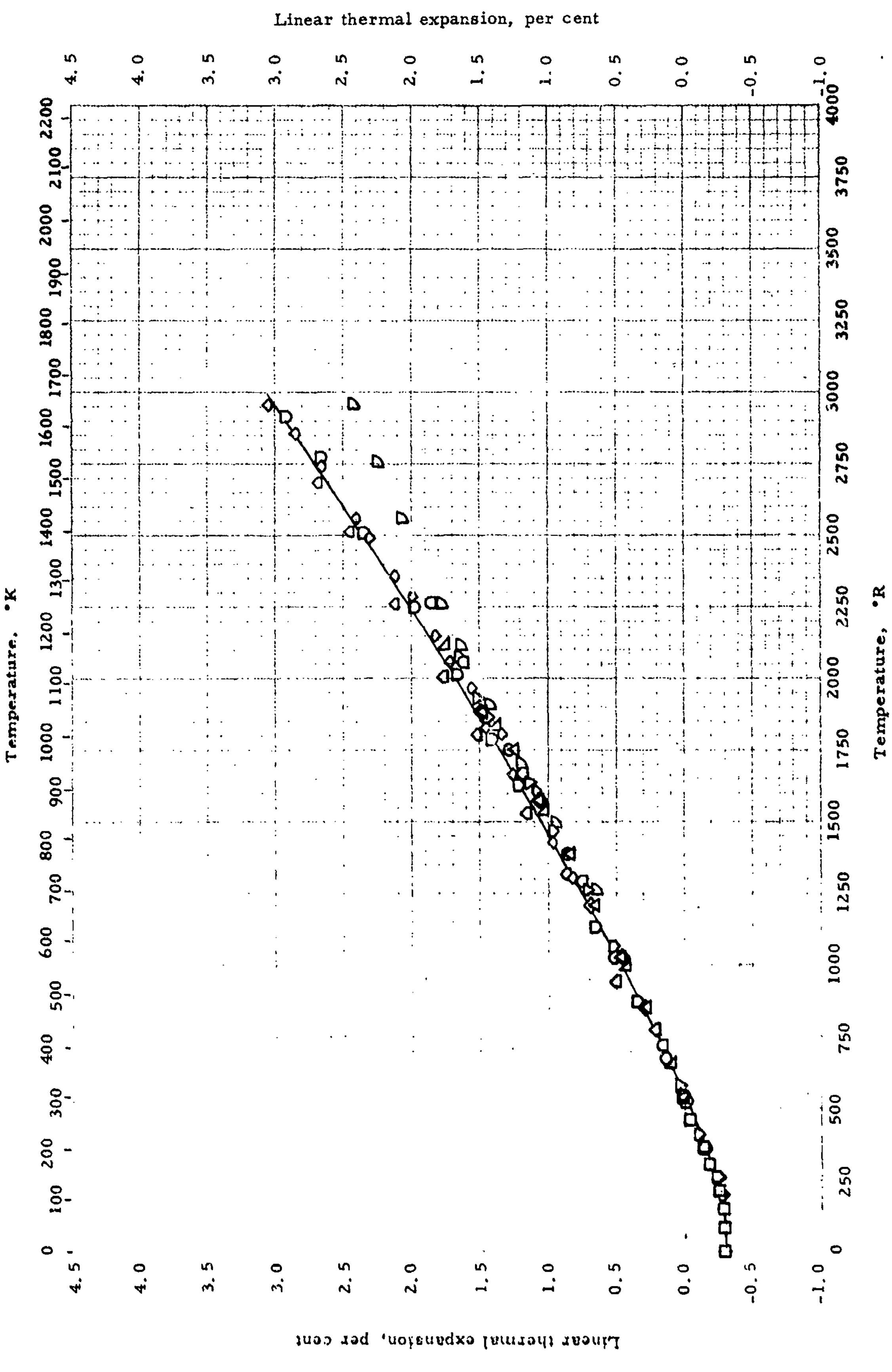


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(13 - 17% Cr; 12 - 13% Ni)

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(13 - 17% Cr; 12 - 13% Ni)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W., and Bollenrath, F.	47-8	852-1932	WF 100 D (Ger. Desig.): 14.8% Cr; 12.9% Ni; 2.5% W; 1.84% Si; 0.52% Mn; 0.38% C; 0.23% Mo. $\rho = 495.3\ lb_m/ft^3$	Bollenrath type comparative dilatometer	Forged at 300°C for extended period
□	Ibid.	47-8	852-1932	DVL 51 (Ger. Desig.): 16.8% Cr; 12.3% Ni; 1.03% B; 0.88% Si; 0.70% Mn; 0.16% C. $\rho = 484.8\ lb_m/ft^3$	Same as above	Forged
△	Oliver, D. A., and Harris, M. A.	52-25	672-2112	Jessop G-21 Steel (Brit. Desig.): 13.0% ea. Cr, Ni; 2.3% W; 1.4% Si; 0.9% ea. Mn, Nb; 0.4% C. $\rho = 501\ lb_m/ft^3$	Not given	
◇	Cornelius, H.	43-17	528-1932	15.8% Cr; 13.0% Ni; 2.1% W; 1.73% Si; 0.74% Mn; 0.50% C	Bollenrath type comparative dilatometer	Tested in vacuum at 1.5°C/min. rise



LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(16 - 19% Cr; 7 - 16% Ni)

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(16 - 19% Cr; 7 - 16% Ni)

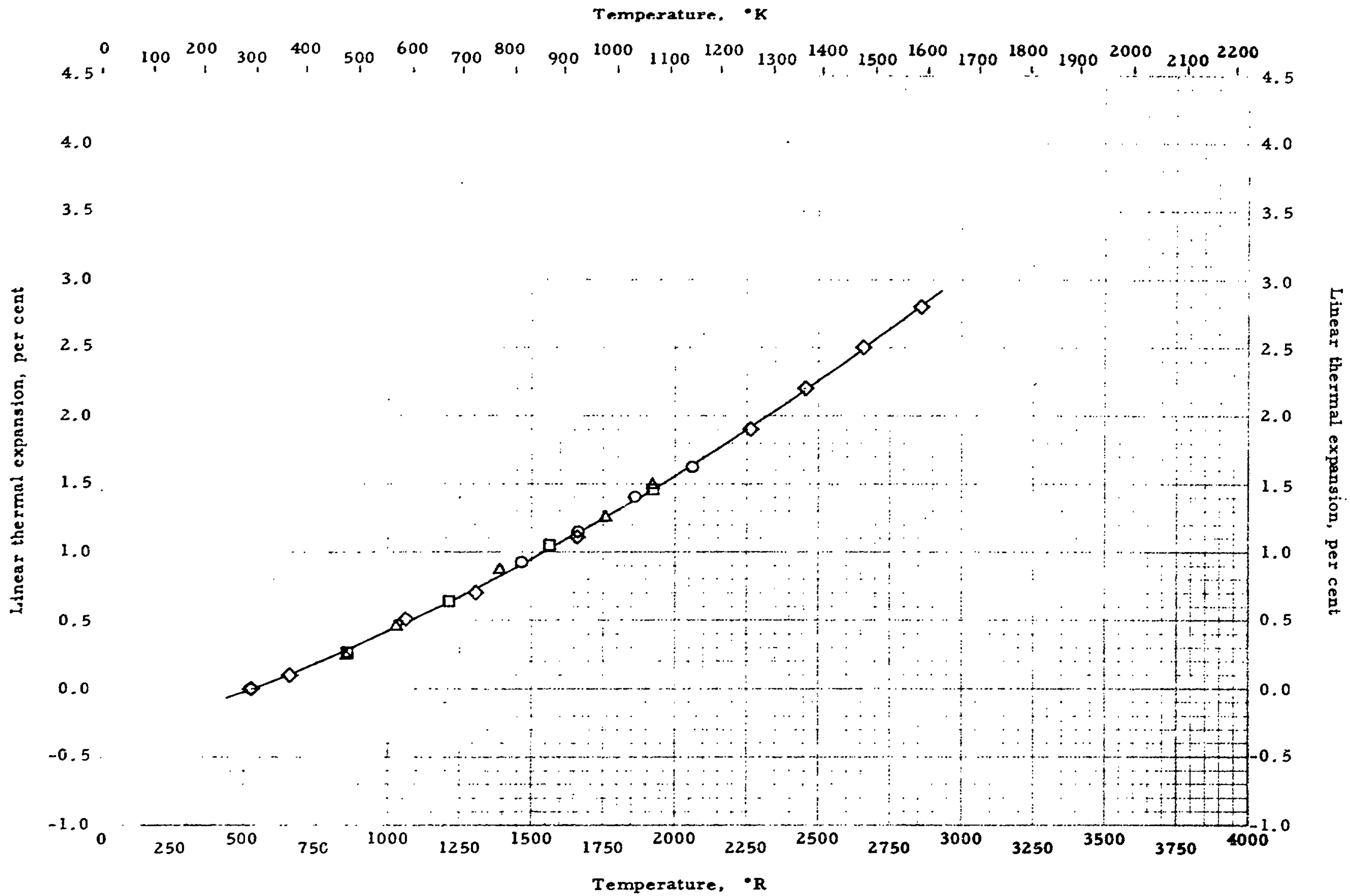
REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kirby, H.W. and Sykes, C.	52-27	672-1752	17.84% Cr; 9.5% Ni; 1.22% Nb; 0.50% Si; 0.41% Mn; 0.11% C; 0.014% P; 0.011% S	Not given	Hot rolled, heated 1/2 hr. at 1050°C, air cooled
□	Altman, H.W., Rubin, T. and Johnston, H. L.	54-39	0-540	A.I.S.I. 304; 18.68% Cr; 8.84% Ni; 1.12% Mn; 0.43% Si; 0.06% Cu; 0.05% C; 0.031% N_2; 0.023% S; 0.017% P	Interferometer	
△	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	852-1932	A.T.S. (Ger. desig.); 18.0-19.3% Cr; 9.2-10.3% Ni; 1.35-1.75% Ta, Nb; 0.70-0.72% Mn; 0.30-0.84% Si; 0.58-0.70% W; 0.13-0.14% C; ρ = 498.1 lb_m/ft^3	Dilatometer	Forged, heated to 1050°C, air cooled
◇	Ibid.	47-8	852-1932	SAS 8 (Ger. desig.); 17.6% Cr; 15.2% Ni; 2.2% Mo; 1.8% Cu; 1.06% total Ta and Nb; 0.1% C; ρ = 492 lb_m/ft^3	Same as above	Rolled, heated to 1050°C, air cooled
▽	Cornelius, H.	43-17	528-2112	17.4-17.6% Cr; 9.1-9.2% Ni; 1.75-1.81% Si; 1.13-1.20% Mn; 1.1-1.15% W; 0.44-0.48% C	Bollenrath type comparative dilatometer	Tested in vacuum at 1.5°C/min. rise
○	Perry, S.	45-6	360-528	72.85% Fe; 18.00% Cr; 9% Ni; <0.15% C; <0.60% Zr + Mo	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
▽	Lucks, C.F. and Deem, H.W.	58-5 51-65	210-2060	A.I.S.I. 347. Nominal: 17-19% Cr; 9-12% Ni; < 0.08% C; % Nb = 10·(% C)	Quartz tube dilatometer	Hot rolled, annealed 1 hr. at 2000°F, water quenched. Tested in vacuum
△	Ibid.	58-5 51-65	210-2260	A.I.S.I. 316. Nominal: 16-18% Cr; 10-14% Ni; 2-3% Mo	Same as above	Same as above
▽	Fieldhouse, I.B., Hedge, J.C. and Lang, J.I.	58-2	540-2909	A.I.S.I. 316	Telemicroscopes sighting on sample	Tested in He atmos.
△	Ibid.	58-2	540-2690	A.I.S.I. 347. Mfg. anal. 17.82% Cr; 10.32% Ni; 1.62% Mn; 0.6% Si; 0.14% Mo; 0.13% Cu; 0.06% C; 0.018% ea. P, S	Same as above	Same as above
△	Neimark, B.E.	55-68	528-2112	15.3-18.1% Cr; 9.82-12.3% Ni; 0-2.76% W; 0.43-0.88% Mn; 0.59-0.74% Si; 0.072% Mo; 0-0.45% Ti; 0.09-0.10% C	Quartz tube dilatometer	Tested at 2°C/min. rise. Results of three samples: 1) as received 2) austenitized 3) stabilized 10 hr. at 800°C. Agreement ± 2.5% of average value plotted
◇	Fieldhouse, I.B., Hedge, J.C. et al.	58-4	540-2521	Stainless Steel Type 17-7PH: 72.21% Fe; 17.30% Cr; 7.06% Ni; 1.11% Al; 0.60% Mn; 0.49% Si; 0.074% C	Telemicroscopes sighting on samples	

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X (Cont'd)
(16 - 19% Cr; 7 - 16% Ni)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
▽	Seibel, R. D. and Mason, G. L.	57-156	1260-2960	Stainless Steel Type 321: 69.05% Fe; 17.59% Cr; 9.85% Ni; 1.33% Mn; 1.17% Ti; 0.71% Si; 0.091% C; 0.009% S; trace P	Alumina tube dilatometer with differential transformer pick-up	
◇	Ibid.	57-156	1260-2960	Stainless Steel Type 17-7 PH: 72.62% Fe; 17.08% Cr; 7.21% Ni; 1.19% Al; 0.71% Mn; 0.70% C; 0.45% Si; 0.024% P; 0.017% S	Same as above	

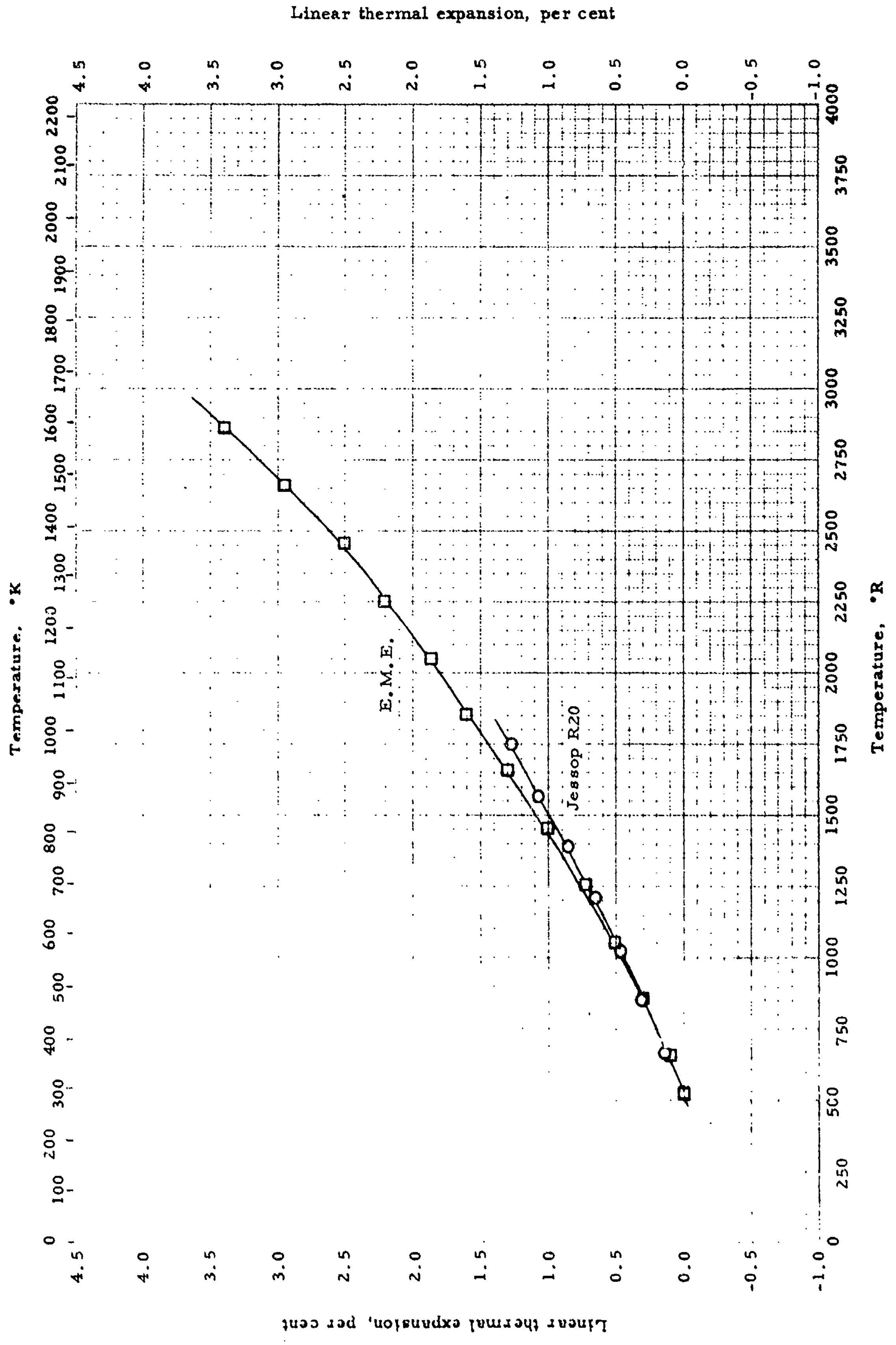


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(18 - 21% Cr; 8 - 11% Ni)

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(18 - 21% Cr; 8 - 11% Ni)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Schoefer, E. A.	53-35	530-2060	HF Grade Alloy: 21% Cr; 9% Ni	Not given	
□	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	852-1932	V444D (Ger. Desig.): 19.2% Cr; 8.8% Ni; 3.0% Si; 1.9% W; 0.43% C. ρ = 496 lb_m/ft^3	Dilatometer	Forged at 800°C for extended period
△	Ibid.	47-8	852-1932	ATS (Ger. Desig.): 18.0 - 19.3% Cr; 9.2 - 10.3% Ni; 1.75 - 1.35% Ta, Nb; 0.72 - 0.70% Mn; 0.84 - 0.30% Si; 0.70 - 0.58% W; 0.13 - 0.14% C. ρ = 498 lb_m/ft^3	Same as above	Forged, heated to 1050°C, air cooled
◇	Apblett, W. R., and Pellini, W. S.	51-5	530-2860	19-9 DL: 19.2% Cr; 9.0% Ni; 1.34% Mo; 1.00% Mn; 0.82% Si; 0.014% N_2	Strain gages on channel-shaped clip fastened to pins welded on sample	

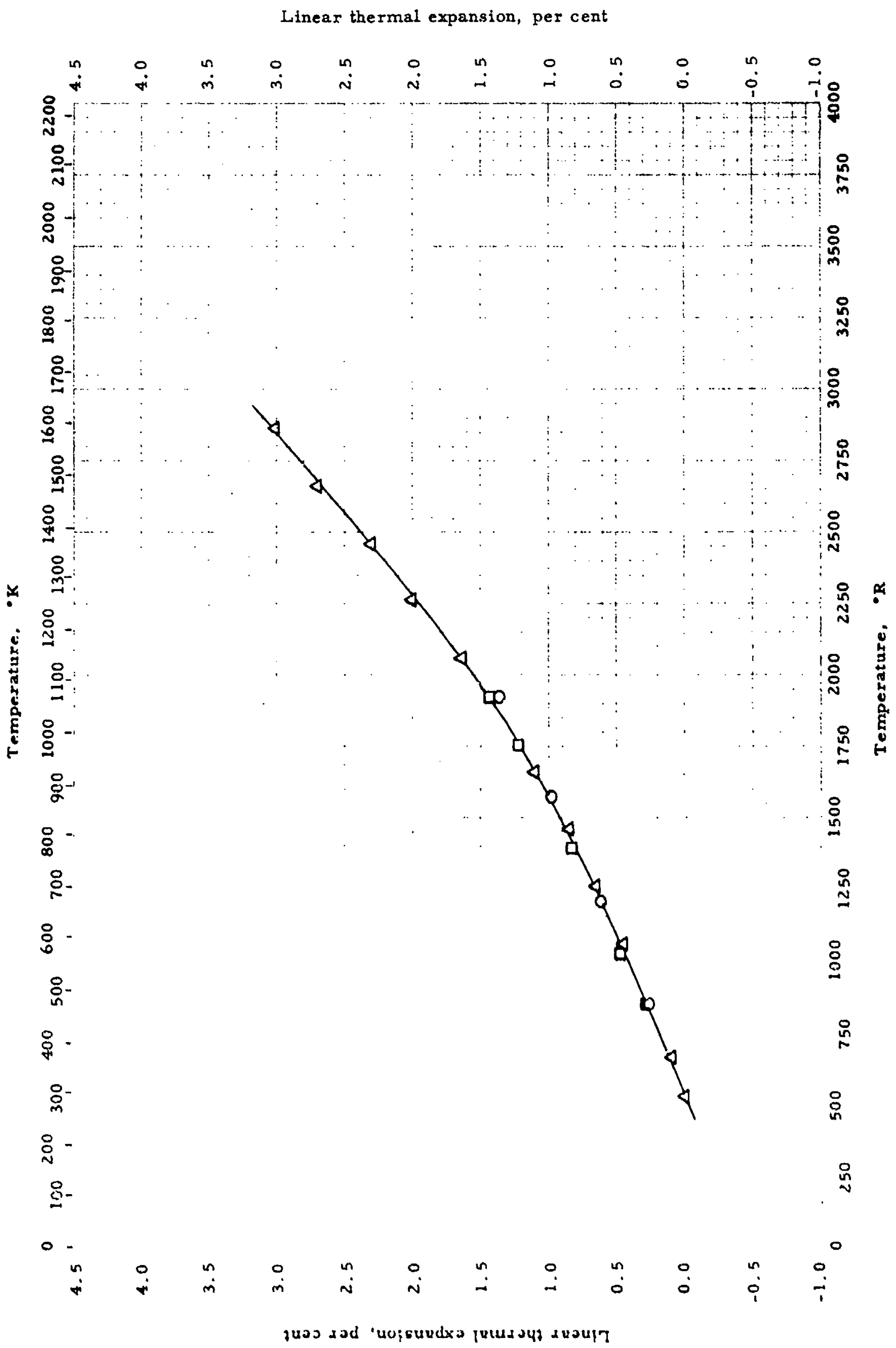


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(19 - 20% Cr; 12 - 14% Ni)

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(19 - 20% Cr· 12 - 14% Ni)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Oliver, D. A., and Harris, M. A.	52-25	672-1752	Jessop R20 (Brit. Desig.); 19.0% Cr; 14.0% Ni; 1.7% Nb; 0.80% Mn; 0.30% Si; 0.15% C. ρ = 494 lb_m/ft^3	Not given	
□	Apblett, W. R., and Pellini, W. S.	51-5	530-2860	E. M. E.; 19.5% Cr; 12.2% Ni; 3.25% W; 1.05% Nb; 0.57% Si; 0.52% Mn; 0.15% C; 0.127% N_2	Strain gages on channel-shaped clip fastened to pins welded on sample	Heating rate: 200°F/sec

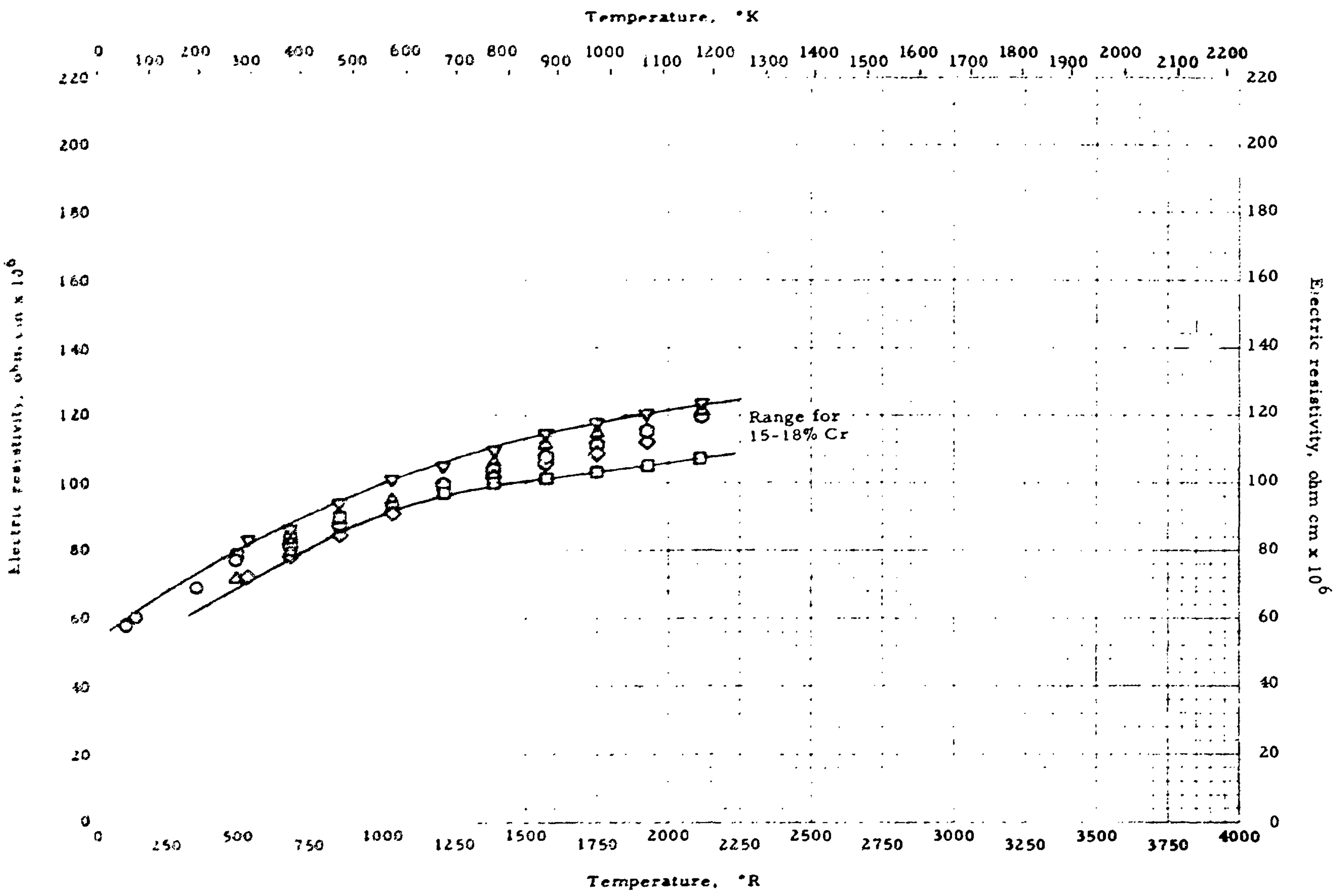


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(20 - 22% Cr; 14 - 20% Ni)

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + NICKEL + X
(20 - 22% Cr; 14 - 20% Ni)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	852-1932	DVL 30 (Ger. Desig.): 21.0% Cr; 14.3% Ni; 3.2% W; 1.61% Mn; 1.60% Si; 1.29% Ti; 0.25% C. ρ = 491.6 lb_m/ft^3	Dilatometer	Forged
□	Ibid.	47-8	852-1932	DVL 52 (Ger. Desig.): 21.1% Cr; 15.3% Ni; 3.3% W; 1.84% Mn; 1.57% Si; 0.88% Ti; 0.22% C. ρ = 493.7 lb_m/ft^3	Same as above	Same as above
△	Appleti, W. R. and Pellini, W. S.	51-5	530-2860	S-590: 20.0% Cr; 18.7% Ni; 7.34% Nb; 4.87% Co; 2.20% W; 1.22% Mo; 1.20% Mn; 0.46% C; 0.40% Si	Strain gages on channel-shaped clip fastened to pins welded on sample	Heating rate: 200°F/sec.



ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL + X

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Tyler, W. W. and Wilson, Jr., A. C.	52-55 also 53-38	115-492	AISI 316 (Allegheny Metal 18-8M); nominal: 16-18% Cr; 10-14% Ni; 2-3% Mo; 0.1% C max.	Not given	Auth. est. accuracy ± 2%. 25% minimum final cold reduction before test
□	Hogan, C.L. and Sawyer, R.B.	52-75	492-2112	Stainless steel 347. Nominal: 18.0% Cr; 11.2% Ni; 1.80% Mn; 0.77% Nb; 0.70% Si; 0.069% C; 0.021% P; 0.007% S	Potential drop; sample temp by Chromel-Alumel thermocouple	
△	Ibid.	52-75	492-2112	Stainless steel 303. Nominal: 18.42% Cr; 8.97% Ni; 0.61% Mn; 0.51% Si; 0.17% C	Same as above	
◇	Neimark, B. E.	55-68	528-2112	18.1% Cr; 9.82% Ni; 0.88% Mn; 0.74% Si; 0.09% C; 0.45% Ti	Potential drop	Initial condition
▽	Ibid.	55-68	528-2112	15.3% Cr; 12.3% Ni; 2.76% W; 0.72% Mo; 0.59% Si; 0.43% Mn; 0.10% C	Same as above	Austenitic condition
○	Ibid.	55-68	672-2112	Same as above	Same as above	Stabilized 10 hr. at 800°C

PROPERTIES OF IRON + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 11% Cr . . .	484 lb_m/ft^3	7.75 g/cm^3
Melting Point 11% Cr .	3190°R*	1770°K*
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	O	484	7.75

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

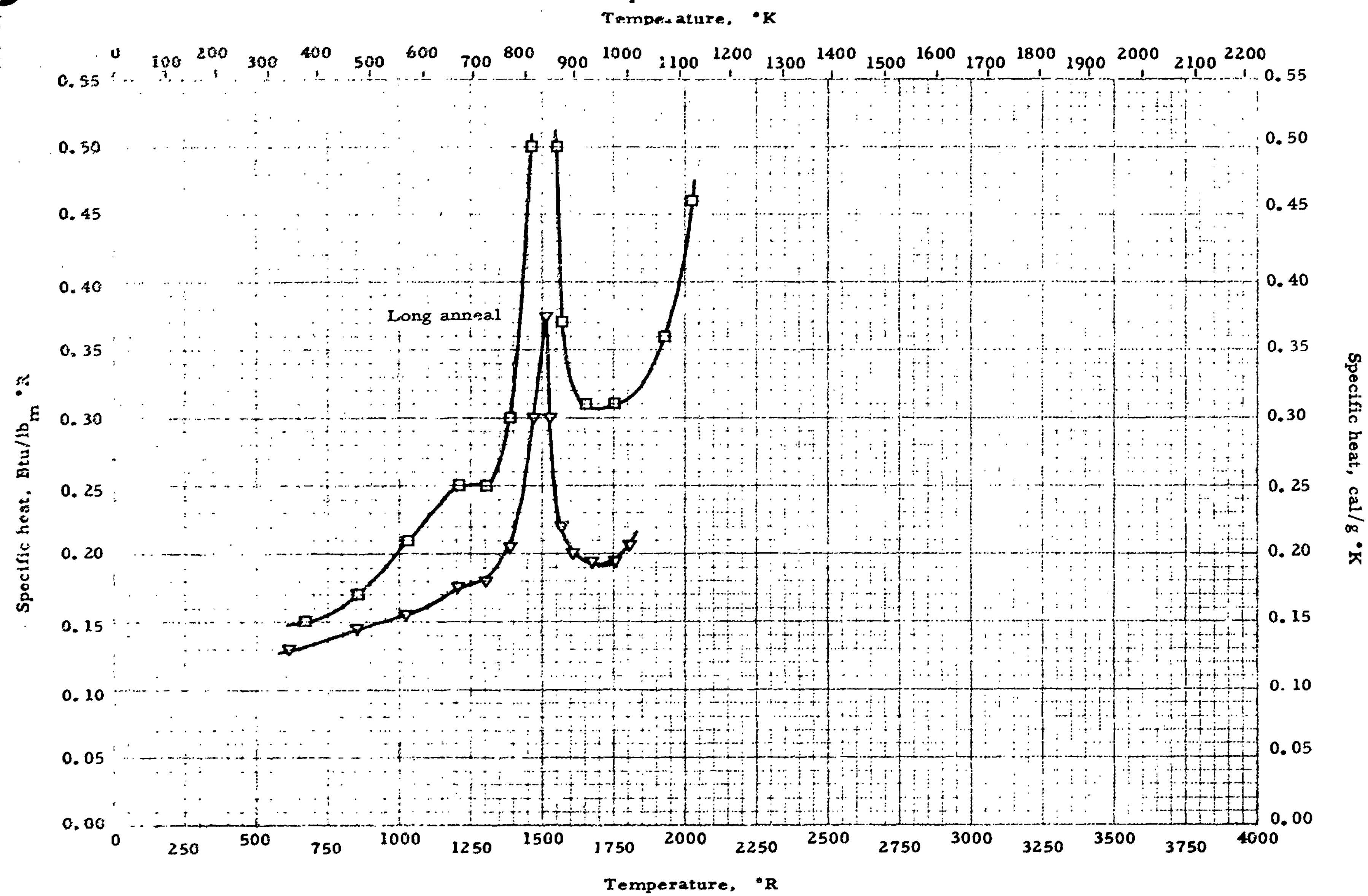
	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Oliver, D. A. and Harris, M. A.	32-25	Room	Jessop No. 46 steel (British designation) 11.0% Cr; 0.7% V; 0.5% Mo; 0.4% Mn; 0.3% Si; 0.2% C; 0.15% Nb;	ρ: Not given	

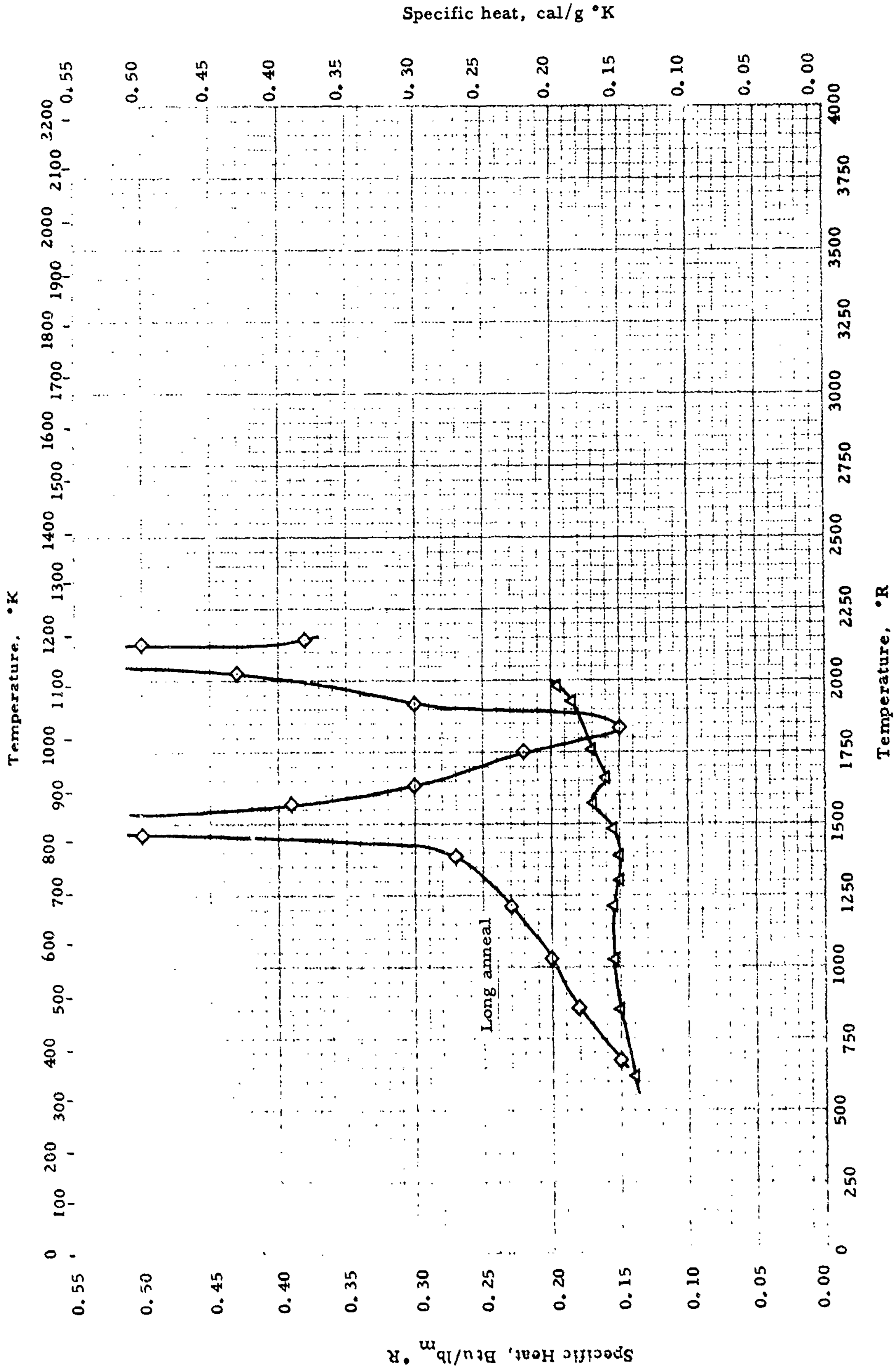


SPECIFIC HEAT -- IRON + CHROMIUM + X
(36% Cr)

SPECIFIC HEAT -- IRON + CHROMIUM + X
(36% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
□	Masumoto, H., Saito, H. and Sugihara, M.	53-129	672-2022	36.45% Cr; 0.58% Si; 0.41% Mn; 0.13% Al; 0.10% C; 0.020% N	Comparative; rate of cooling of sample compared to that of standard	Heated 3 hr. at 1000 °C, furnace cooled to 800 °C, cooled to room temp. at 30 °C per hr., heated 200 hr. at 475 °C
▽	Ibid.	53-129	618-1806	Same as above	Same as above	Heated 3 hr. at 1000 °C, furnace cooled to 800 °C, cooled to room temp. at 30 °C per hr

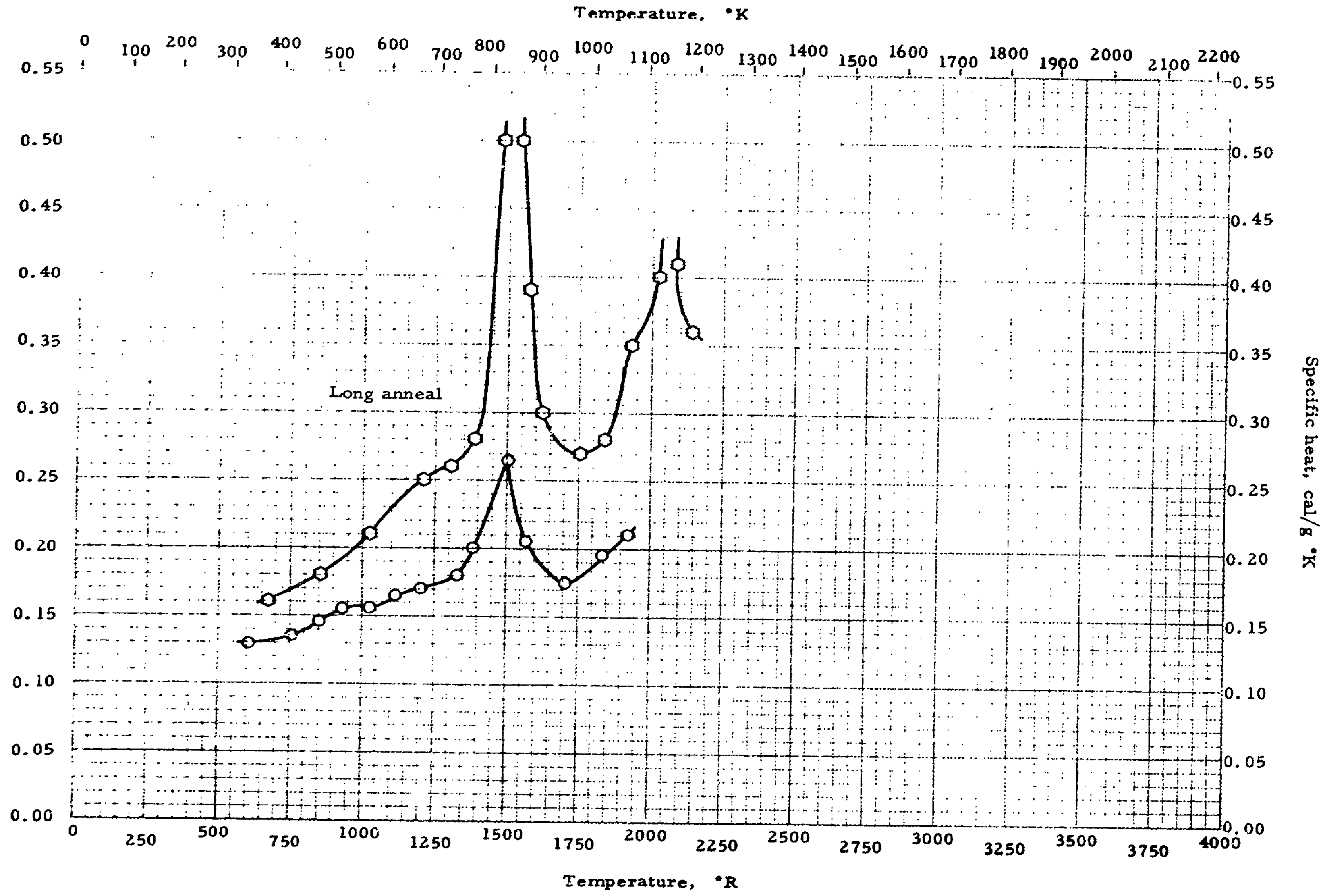


SPECIFIC HEAT -- IRON + CHROMIUM + X
(43% Cr)

SPECIFIC HEAT -- IRON + CHROMIUM + X (43% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
△	Masumoto, H., Saito, H. and Sugihara, M.	53-129	618-1986	43.16% Cr; 0.72% Si; 0.32% Mn; 0.14% Al; 0.11% C; 0.025% N	Comparative; rate of cooling of sample compared to that of standard	Heated 3 hr. at 1000 °C, furnace cooled to 800 °C; cooled to room temp. at 30 °C per hr.
◇	Ibid.	53-129	672-2148	Same as above	Same as above	Same as above; heated 200 hr. at 475 °C

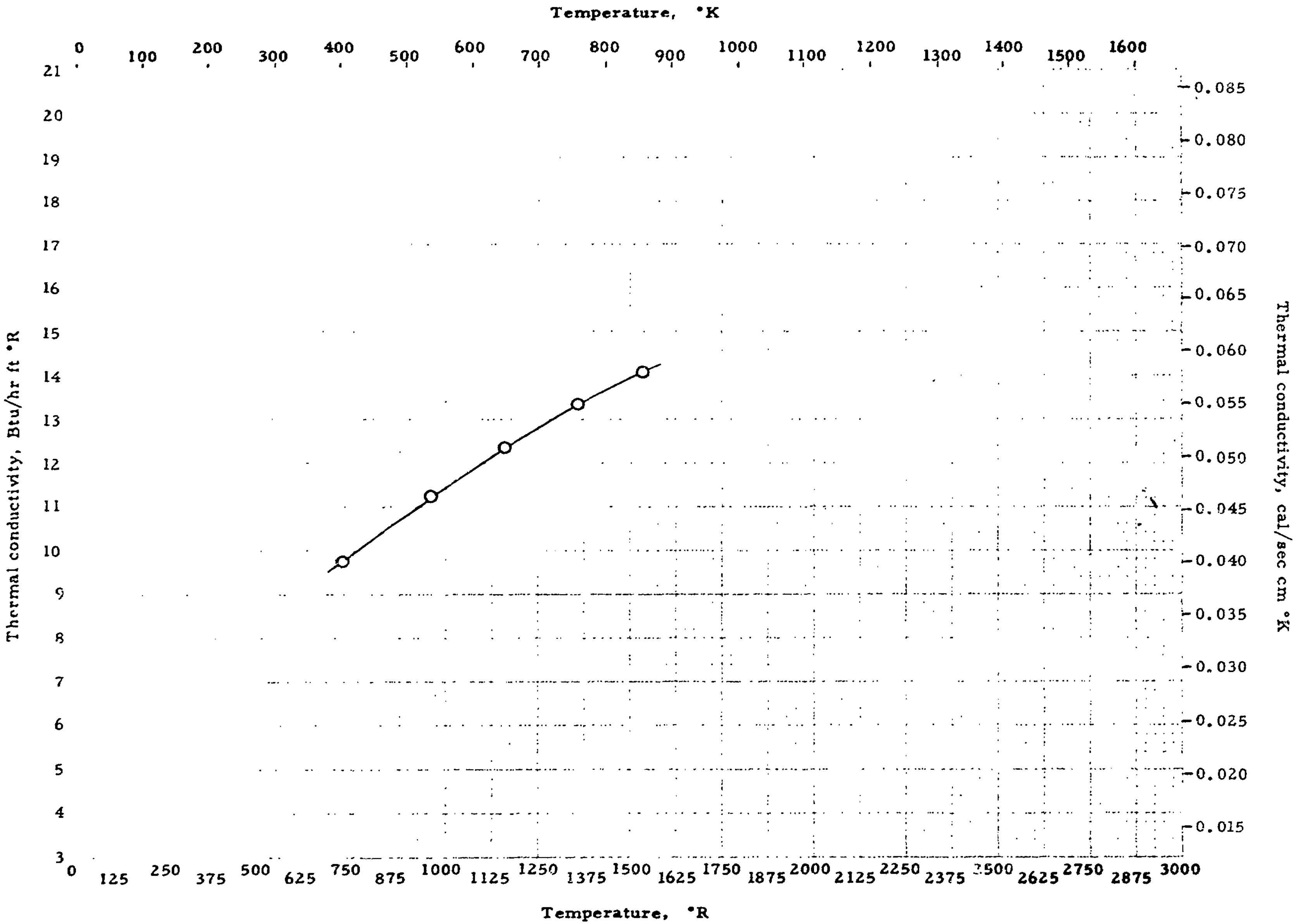


SPECIFIC HEAT -- IRON + CHROMIUM + X
(48% Cr)

SPECIFIC HEAT -- IRON + CHROMIUM + X (48% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Masumoto, H., Saito, H. and Sugihara, M.	53-129	618-1932	48.35% Cr; 0.76% Si; 0.44% Mn; 0.12% Al; 0.11% C; 0.022% N	Comparative; rate of cooling compared to that of standard	Heated 3 hr. at 1000°C, furnace cooled to 800°C, cooled to room temp. at 30°C per hr.
O	Ibid.	53-129	672-2148	Same as above	Same as above	Same as above; heated 200 hr. at 475°C

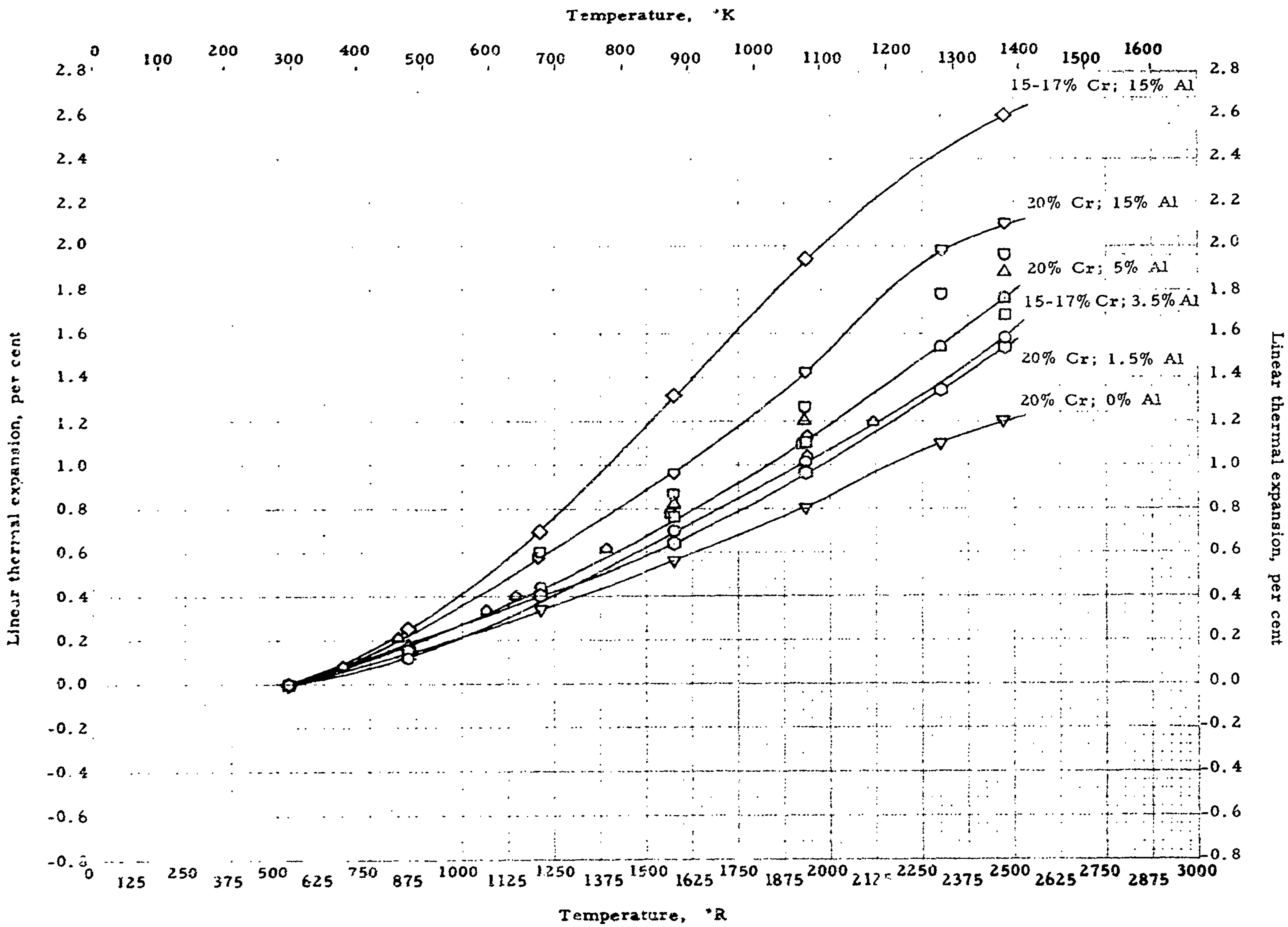


THERMAL CONDUCTIVITY -- IRON + CHROMIUM + COBALT + X

THERMAL CONDUCTIVITY -- IRON + CHROMIUM + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Evans, Jr. J.E.	51-16	720-1535	N-155 (low C); 20.0% Cr; 20.0% Co; 3.25% Mo; 2.5% W; 1.1% Nb; 0.2% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%

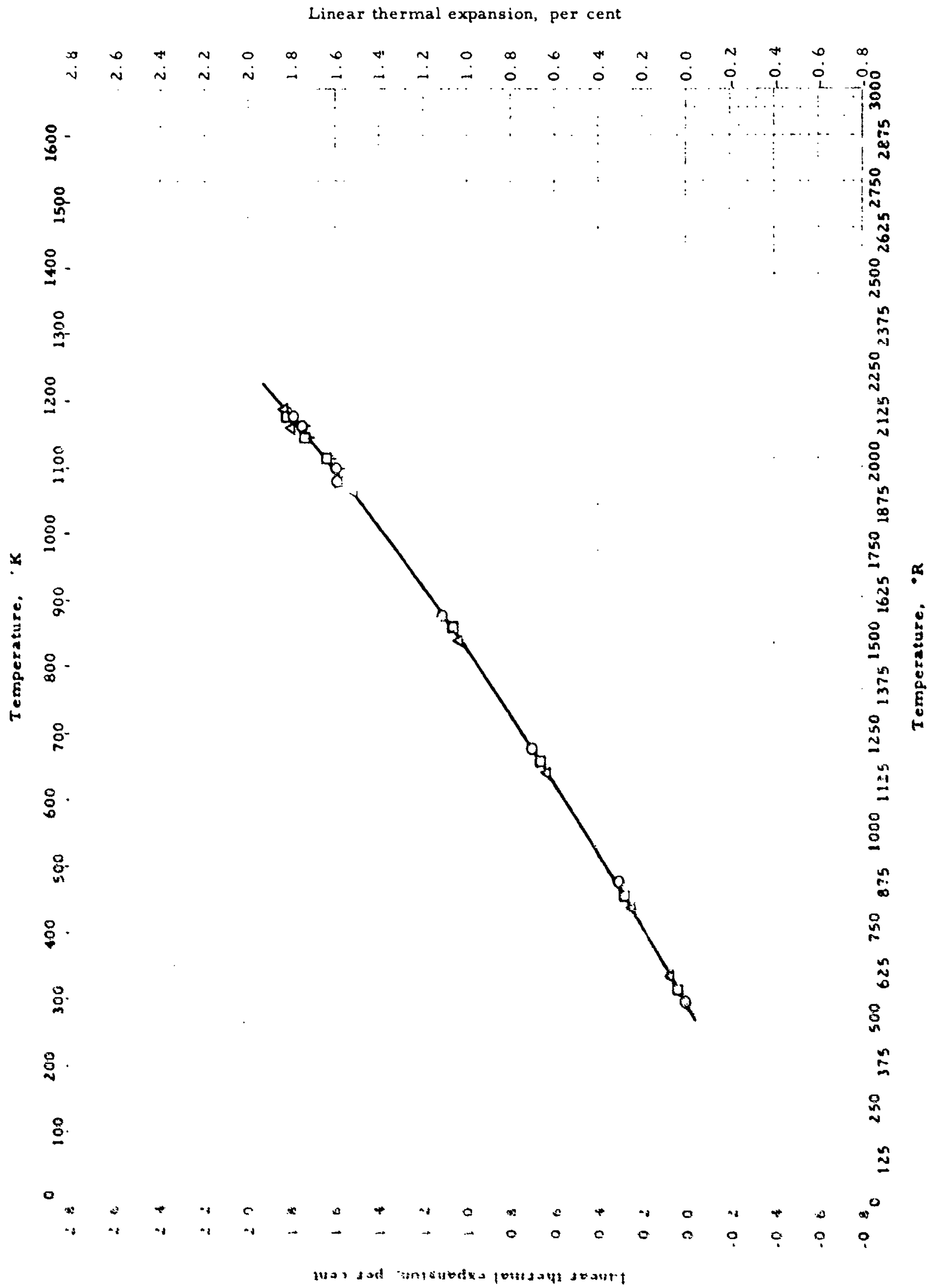


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + ALUMINUM + X

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + ALUMINUM + X

REFERENCE INFORMATION

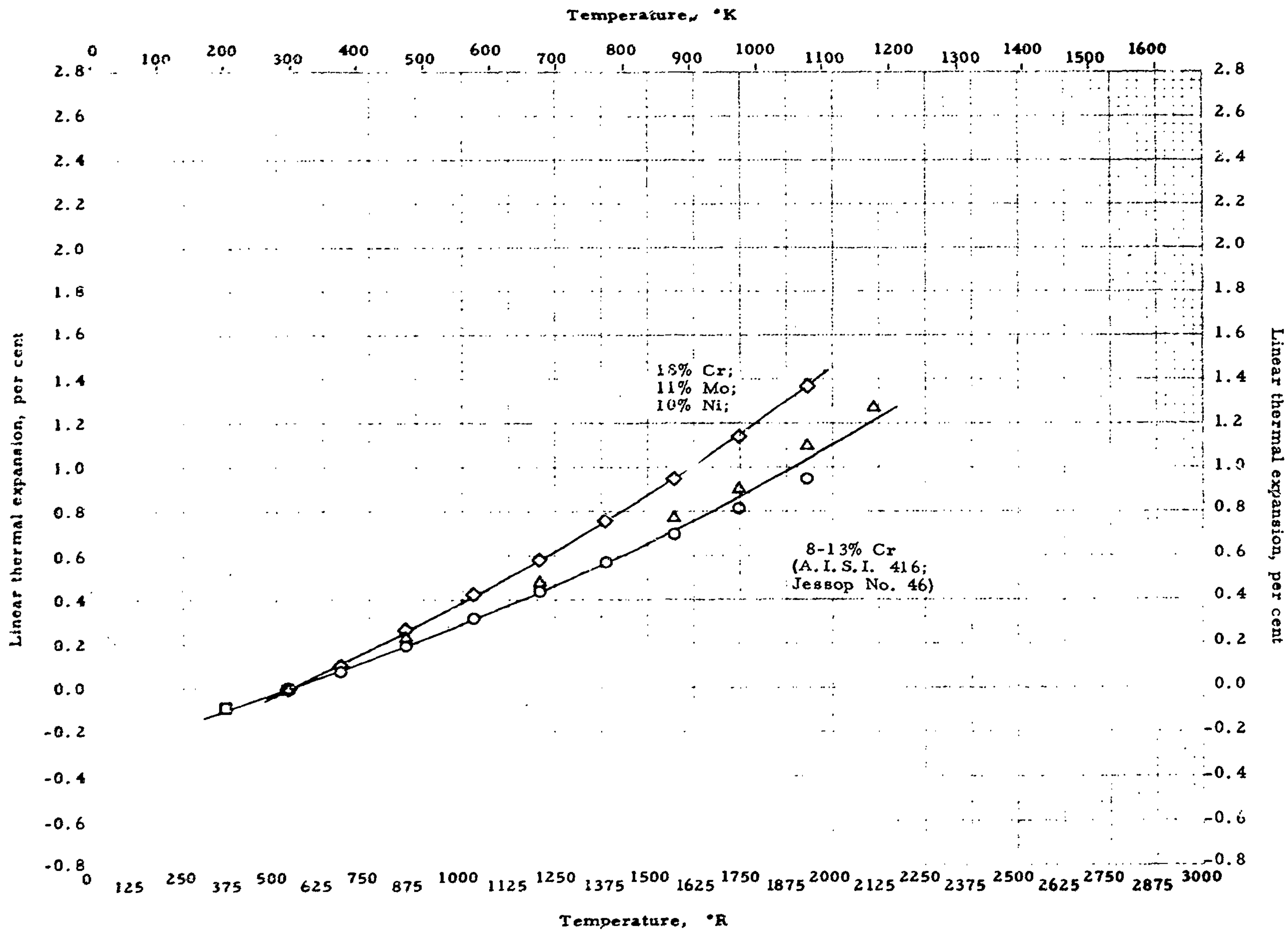
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kornilov, I.I., and Mikheev, V.S., et al.	46-9	528-2472	15-17% Cr; 3.5% Al; 0.08-0.15% Si; 0.02-0.04% C; 0.008% S	Dilatometer	Annealed
□	Ibid.	46-9	528-2472	15-17% Cr; 5.5% Al; impurities same as above	Same as above	Same as above
△	Ibid.	46-9	528-2472	15-17% Cr; 9% Al; impurities same as above	Same as above	Same as above
◇	Ibid.	46-9	528-2472	15-17% Cr; 15% Al; impurities same as above	Same as above	Same as above
▽	Ibid.	46-9	528-2472	20% Cr, 0% Al; impurities same as above	Same as above	Same as above
○	Ibid.	46-9	528-2472	20% Cr; 1.5% Al; impurities same as above	Same as above	Same as above
○	Ibid.	46-9	528-2472	20% Cr; 5% Al; impurities same as above	Same as above	Same as above
○	Ibid.	46-9	528-2472	20% Cr; 10% Al; impurities same as above	Same as above	Same as above
▽	Ibid.	46-9	528-2472	20% Cr; 15% Al; impurities same as above	Same as above	Same as above
⌂	Kuz'menko, P. P.	55-81	528-2112	18.53% Cr; 5.8% Al; 0.29% Si; 0.04% C; 0.018% Mn	X-ray diffraction	⌂ : annealed 100 hr. at 1200°C ⌂ : annealed 5 hr. at 1200°C



LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + MANGANESE + X

REFFRENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H.	43-17	528-2112	Austenitic Steel: 14.8% Cr; 6.5% Mn; 3.2% Ni; 2.3% Si; 0.50% C; 0.4% W; 0.065% N_2	Quartz tube dilatometer, Leitz-Bollenrath. Tested in vac. at 1.5°C/min. rise	○ - heating ⚲ - cooling, Y mixed crystals
□	Ibid.	43-17	528-2112	Austenitic Steel: 14.8% Cr; 6.3% Mn; 4.8% Ni; 1.1% V, 0.46% C; 0.18% N_2	Same as above	□ - heating □ - cooling, Y mixed crystals
△	Ibid.	43-17	528-2112	Austenitic Steel: 12.8% Cr; 6.7% Mn; 5.1% Ni; 3.2% Si; 1.2% W; 0.45% C; 0.16% N_2	Same as above	△ - heating △ - cooling, Y mixed crystals

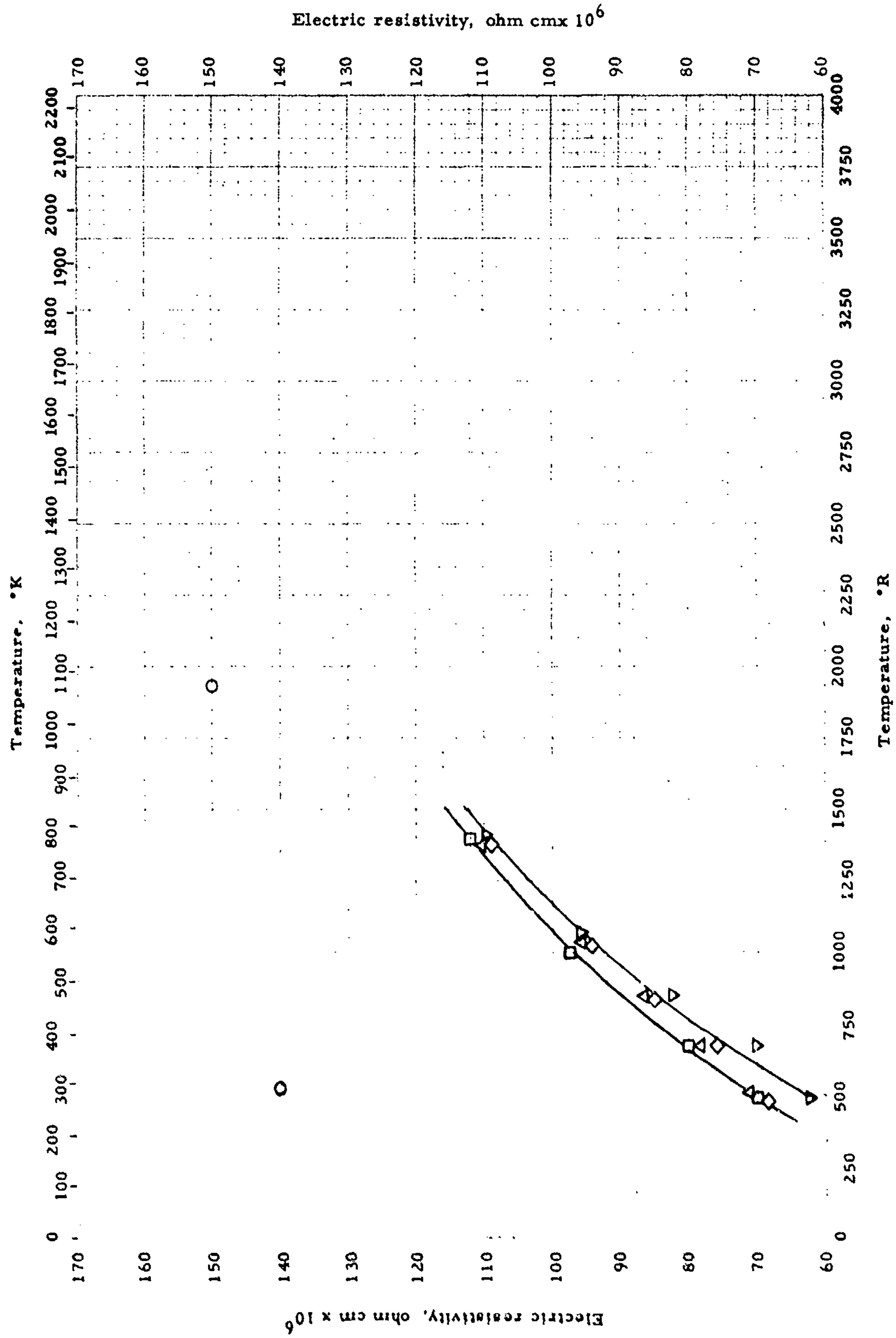


LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + X

LINEAR THERMAL EXPANSION -- IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Oliver, D. A., and Harris, M. A.	52-25	528-1932	Jessop No. 46 Steel (Brit. Desig.); 11.0% Cr; 0.7% V; 0.5% Mo; 0.4% Mn; 0.3% Si; 0.2% C; 0.15% Nb. $\rho = 484\ lb_m/ft^3$	Not given	
□	Perry, S.	45-6	360-528	A.I.S.I. 416, 13% Cr; 0.60% max Zr + Mo; 0.15% max C; 0.07% min. P, S, Se	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
△	Cornelius, H.	43-17	528-2112	8-13% Cr; 0.35-3.0% Si; 0.4-2.2% C; ~0.5% Mn; balance Fe	Bollenrath type comparative dilatometer	Tested in vacuum at 1.5°C/min. rise
◇	Cornelius, H., Bungardt, W., and Bollenrath, F.	47-8	852-1932	B-759 (Ger. Desig.); 17.9% Cr; 10.9% Mo; 10.3% Ni; 1.2% Si; 1.0% Mn; 0.34% C	Bollenrath type comparative dilatometer	Forged

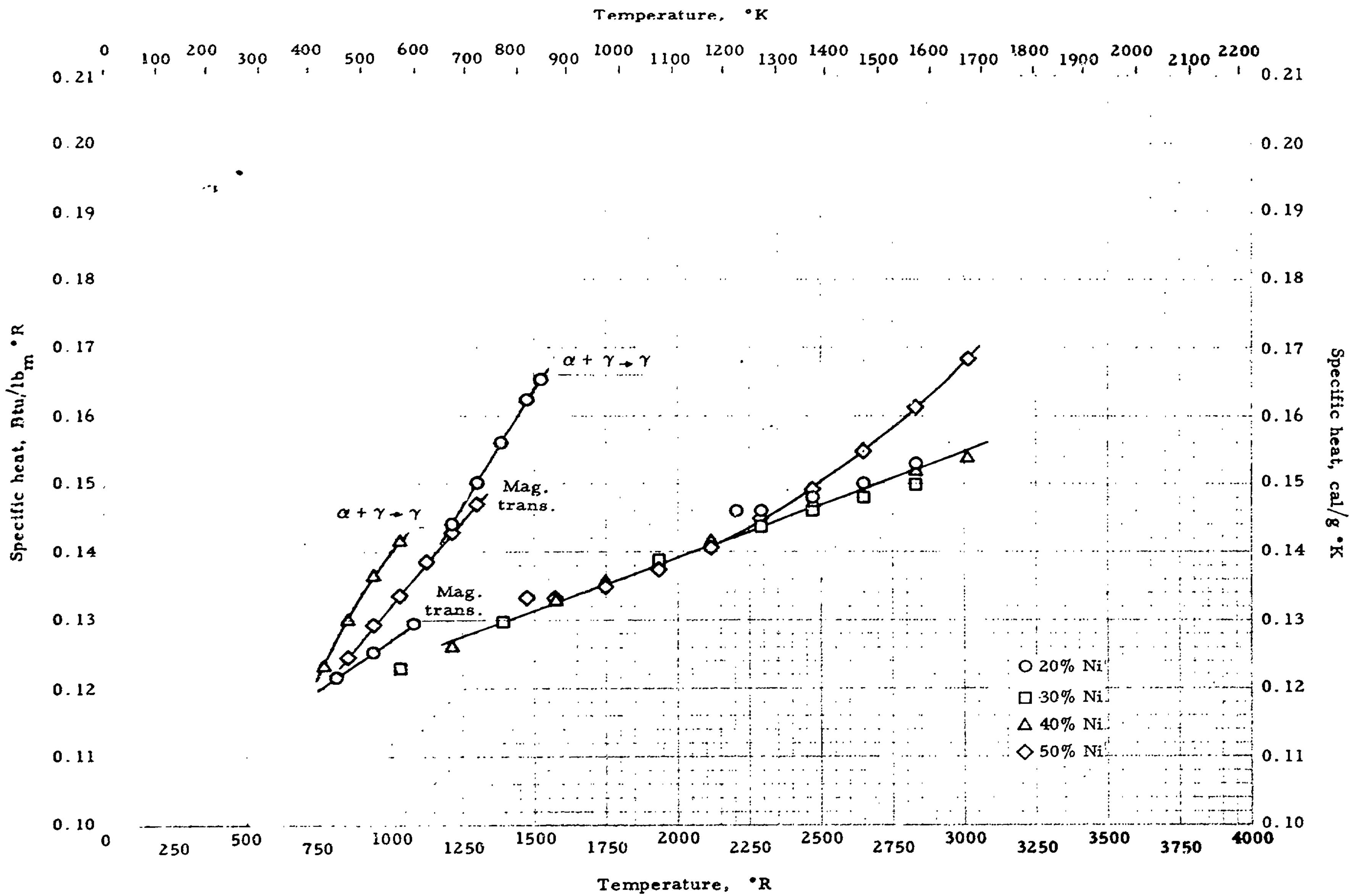


ELECTRIC RESISTIVITY -- IRON + CHROMIUM + X

ELECTRIC RESISTIVITY -- IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Thomas, H.	50-31	528-1932	10.2% Cr; 7.9% Al	Self registering photographic method; potential drop	Low accuracy
□	Matsukura, T.	52-93	492-1392	12.06% Cr; 3.10% W; 2.04% C; 0.46% Mn; 0.17% Ni; 0.13% Si; 0.018% P; 0.008% S	Potential drop	20 min. at 1130°C; air cooled to 500°C; placed in furnace at 500°C and furnace cooled at natural cooling rate of furnace
△	Ibid.	52-93	492-1392	Same as above	Same as above	Air cooled from 1050°C to 500°C; then furnace cooled
◇	Ibid.	52-93	492-1392	Same as above	Same as above	Air cooled from 1000°C to 500°C; then furnace cooled
▽	Ibid.	52-93	492-1392	Same as above	Same as above	Air cooled from 950°C to 500°C; then furnace cooled

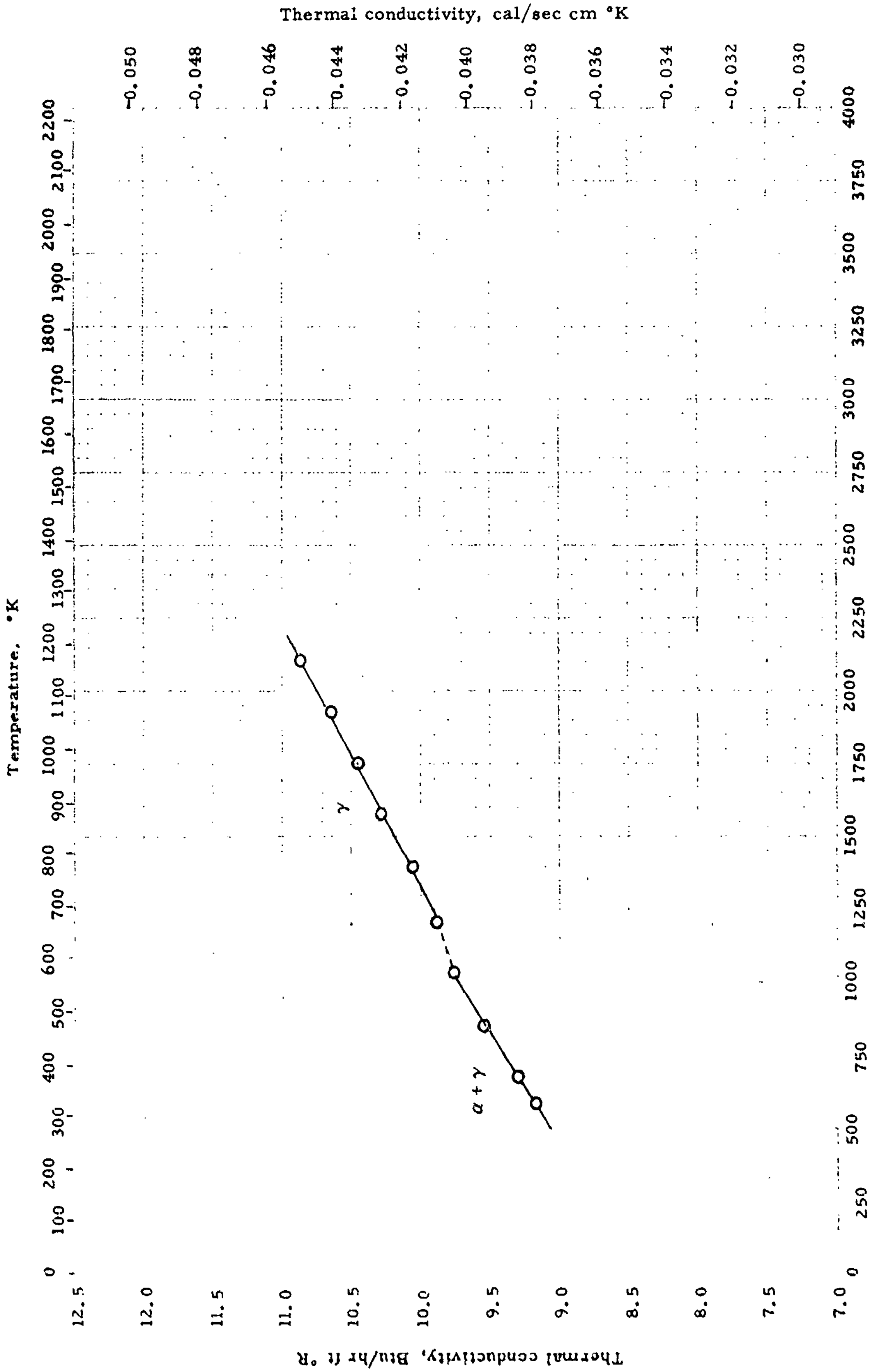


SPECIFIC HEAT -- IRON + NICKEL

SPECIFIC HEAT -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Zuithoff, A. C.	40-7	807-2832	80.7% Fe; 19.3% Ni	Drop method	
□	Ibid.	40-7	1032-2832	70.5% Fe; 29.5% Ni	Same as above	
△	Ibid.	40-7	762-3012	61.0% Fe; 39.0% Ni	Same as above	
◇	Ibid.	40-7	852-3012	50.98% Fe; 49.02% Ni	Same as above	

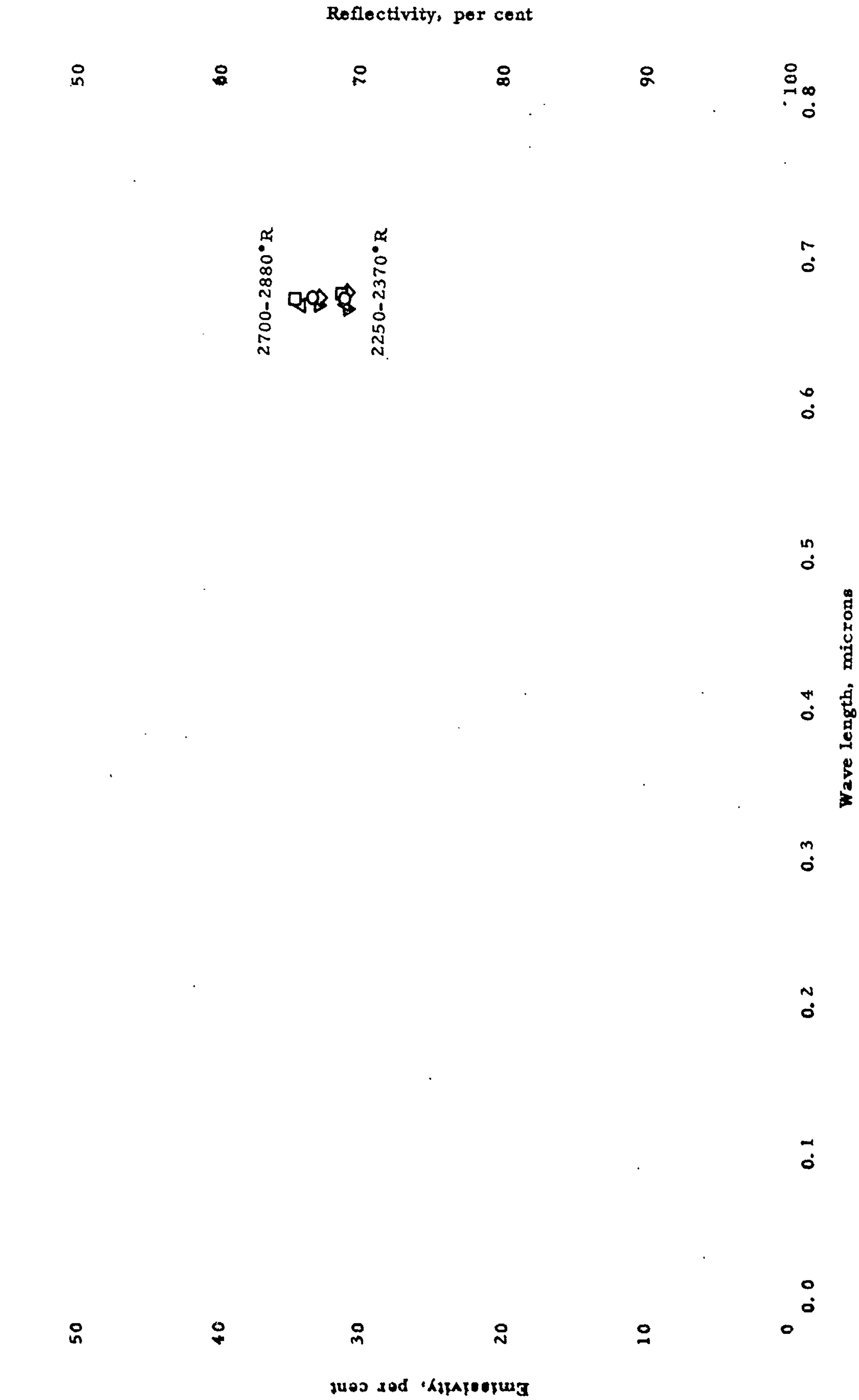


THERMAL CONDUCTIVITY -- IRON + NICKEL

THERMAL CONDUCTIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Silverman, L.	53-2	582-2112	55.8% Fe; 43.91% Ni; 0.22% Mn; 0.050% C; 0.003% S	Comparative; rods	

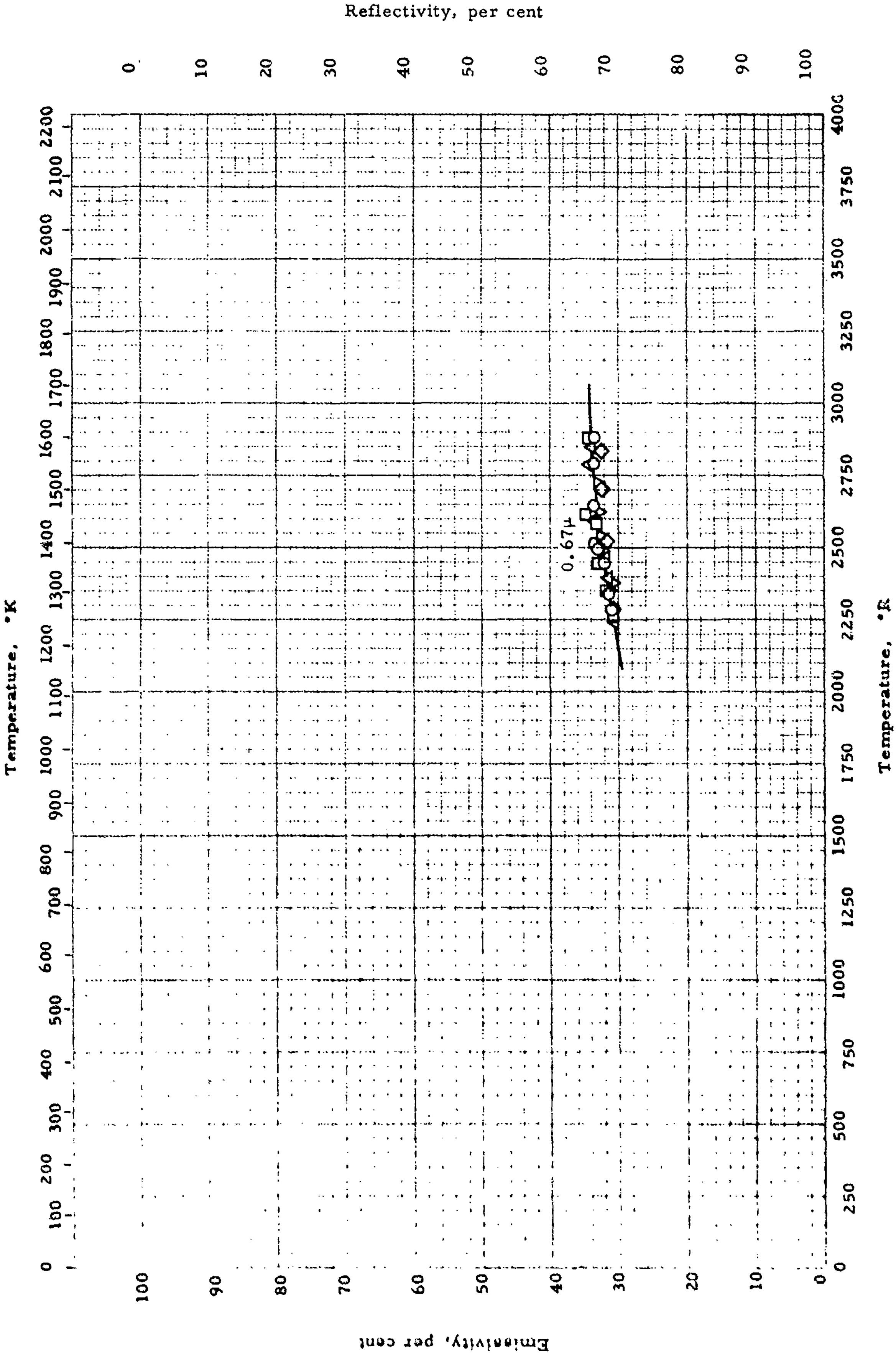


SPECTRAL EMISSIVITY -- IRON + NICKEL

SPECTRAL EMISSIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wahlin, H. B., Zenter, R. and Martin, J.	52-112	2286-2880	Invar: 38% Ni	Spectral normal emissivity: Comparative: surface brightness compared with that of a black body hole.	Prepared from fine powders of reagent quality, cold pressed at 70,000 psi, sintered 48 hr. at 1100°C in H_2 Atm., rolled and annealed. Auth. explain emissivity changes by density changes caused by phase transformations.
□	Ibid.	52-112	2286-2880	Invar: 42% Ni	Same as above	Same as above
△	Ibid.	52-112	2250-2880	Invar: 44% Ni	Same as above	Same as above
◇	Ibid.	52-112	2286-2830	25% Ni	Same as above	Same as above
▽	Ibid.	52-112	2367-2700	50% Ni	Same as above	Same as above

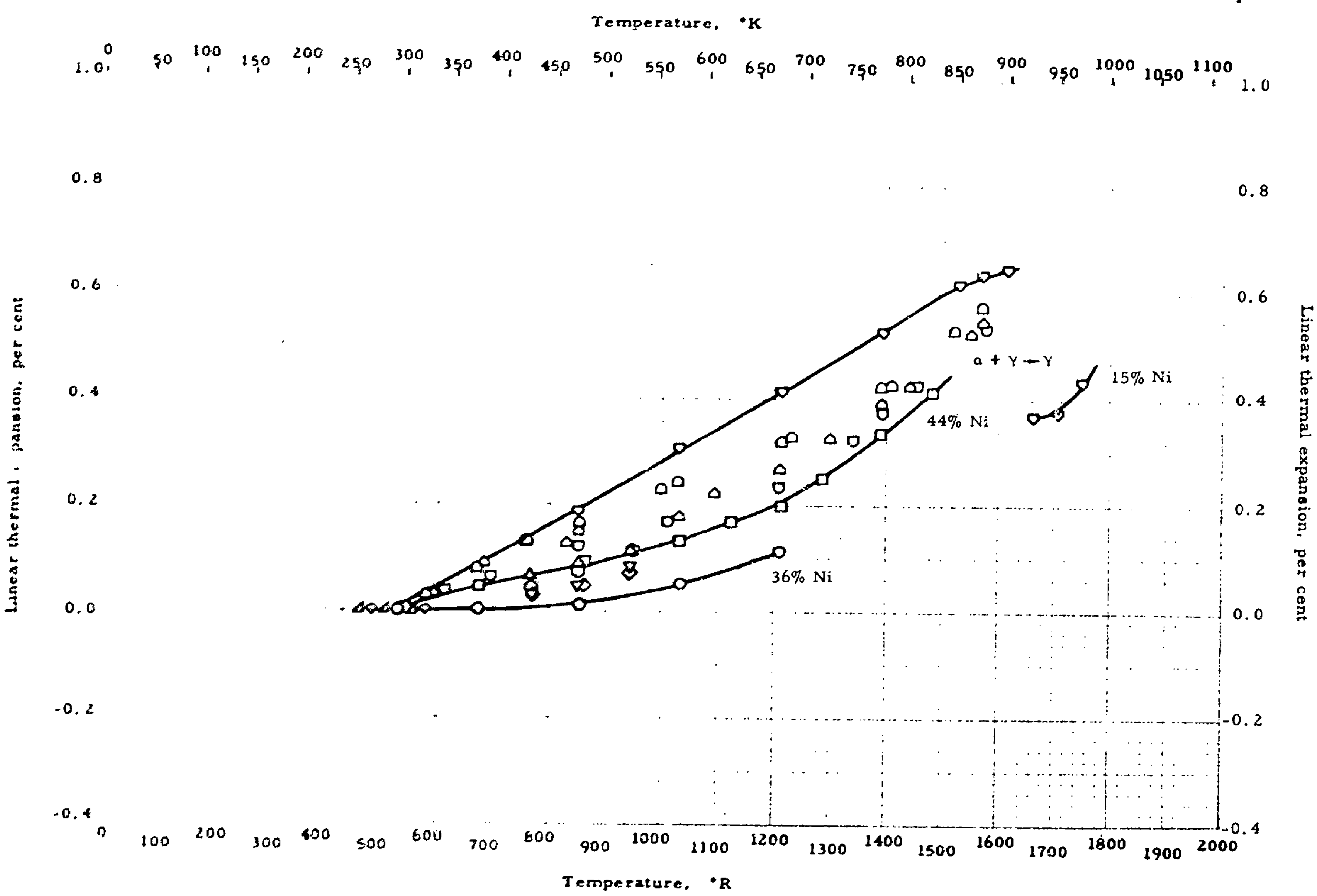


EMISSIVITY -- IRON + NICKEL

EMISSIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wahlin, H. B., Zenter, R. and Martin, J.	52-112	22[illegible]0-2880	Invar: 38% Ni	Spectral normal emissivity at 0.67μ : surface brightness compared with that of a black body hole.	Prepared from fine powders of reagent quality, cold pressed at 70,000 psi, sintered 48 hr. at 1100°C in H_2 atmos. Rolled and annealed.
□	Ibid.	52-112	22[illegible]-2880	Invar: 42% Ni	Same as above	Same as above
△	Ibid.	52-112	2250-2880	Invar: 44% Ni	Same as above	Same as above
◇	Ibid.	52-112	2290-2830	25% Ni	Same as above	Same as above
▽	Ibid.	52-112	2367-2700	50% Ni	Same as above	Same as above

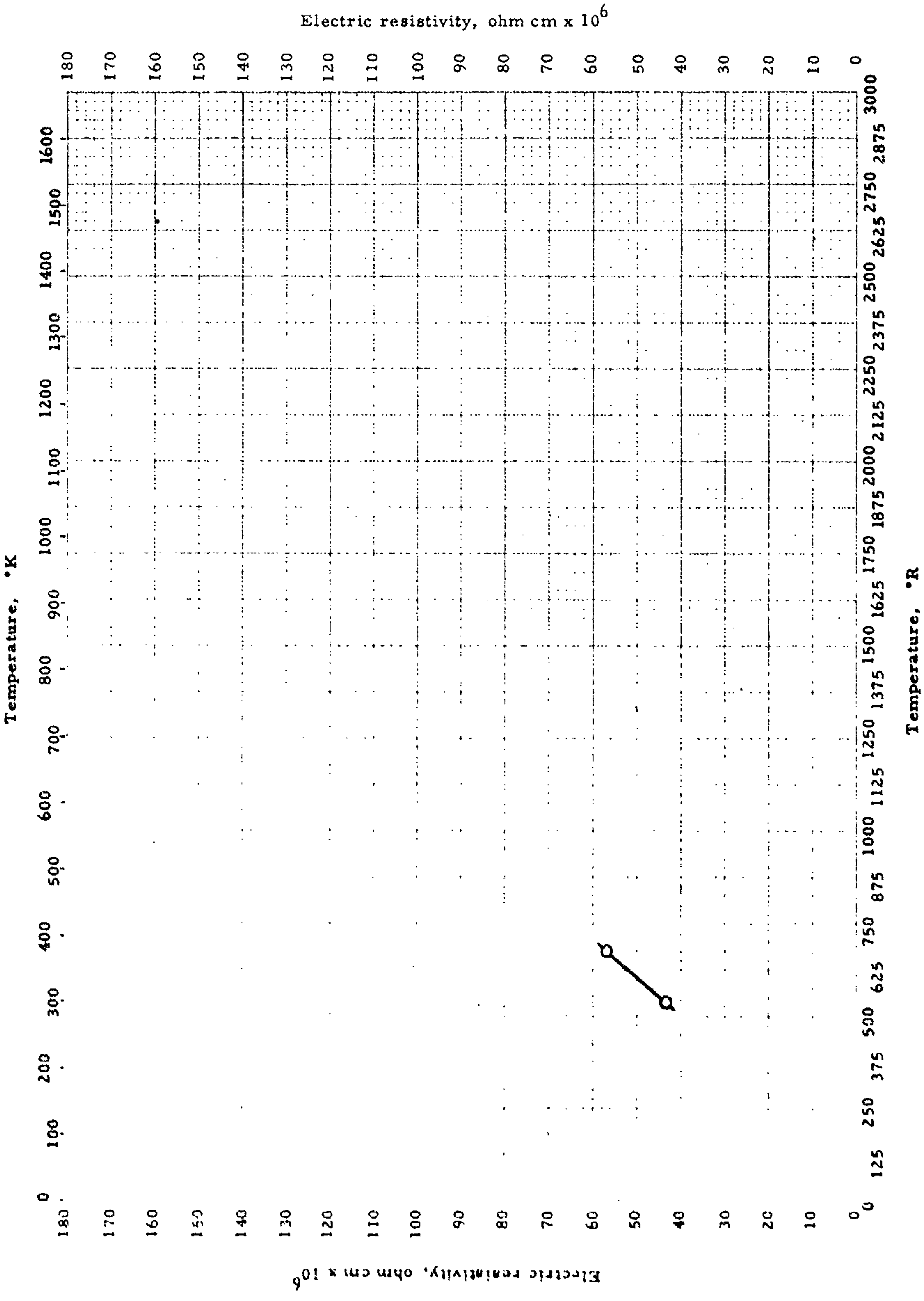


LINEAR THERMAL EXPANSION -- IRON + NICKEL

LINEAR THERMAL EXPANSION -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pupke, G.	57-12	528-1212	Feni 36: 36.3% Ni; 0.10% Mn; 0.01% C	Dilatometer	Vacuum melted, hot rolled at 1200 °C from 75 to 20 mm, reheated to 1000 °C, water quenched, cold rolled to 1 mm, aged 8 hr. at 100 °C, cooled slowly
□	Millner, T. and Welssz, R.	56-126	528-1212	55.4% Fe; 43.9% Ni; 0.01% C	Chevenard quartz tube dilatometer	Prepared from Swedish Armco Iron, electrolytic nickel, and electrolytic cobalt. Induction melted, cast, forged
△	Brookhaven Natl. Laboratory	50-54	528-942	42% Ni	Not given	
◇	Ibid.	50-54	762-942	Plain Invar H	Not given	
▽	Ibid.	50-54	762-942	Plain Invar H	Not given	
○	Ibid.	50-54	762-942	Free Cut Invar H	Not given	
○	Thomas, V. and Jones, D.J.	56-127	580-1572	52.4% Fe; 47.5% Ni; 0.06% Cu; 0.02% Mn; 0.005% C; 0.004% S	Fused quartz tube dilatometer	Compacted Swedish Sponge Iron and Carbonyl Nickel powders, sintered, annealed 15 min. at 850 °C, cooled slowly
△	Ibid.	56-127	580-1572	54.5% Fe; 45.4% Ni; 0.03% Cu; 0.02% Mn; 0.005% C; 0.004% S	Same as above	Same as above
▽	Ibid.	56-127	580-1572	56.5% Fe; 43.4% Ni; 0.06% Cu; 0.02% Mn; 0.005% C; 0.005% S	Same as above	Same as above
▽	Jones, F.W. and Pumphrey, W.I.	49-55	852-1752	15.2% Ni	Quartz tube dilatometer. Sample temp. by thermocouple	Remelted from 99.95% Fe and 99.91% Ni in H_2 atm., forged, descaled, homogenized at 1250 °C in vac.
◺	Bates, L.F. and Weston, J.C.	40-18	450-550	Invar: 36% Ni	Computed from energy balance for rod with suddenly applied force	Auth. est. accuracy ± 2%
◇	Lement, B.S. and Averbach, B.L.	52-123	528-582	Invar: regular and special	Not described here, refers to others	Water quenched from 1525 °F. Also gives data for many other treatments



ELECTRIC RESISTIVITY -- IRON + NICKEL

ELECTRIC RESISTIVITY -- IRON + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Viting, L. M.	57-69	537-672	46.2% Ni; <0.01% C; prepared from electrolytic Ni and Fe	Potential drop	Annealed by slow cooling from 490 to 400°C over 1200 hr. period

PROPERTIES OF IRON + NICKEL + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 40% Fe	480 lb_m/ft^3	7.7 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

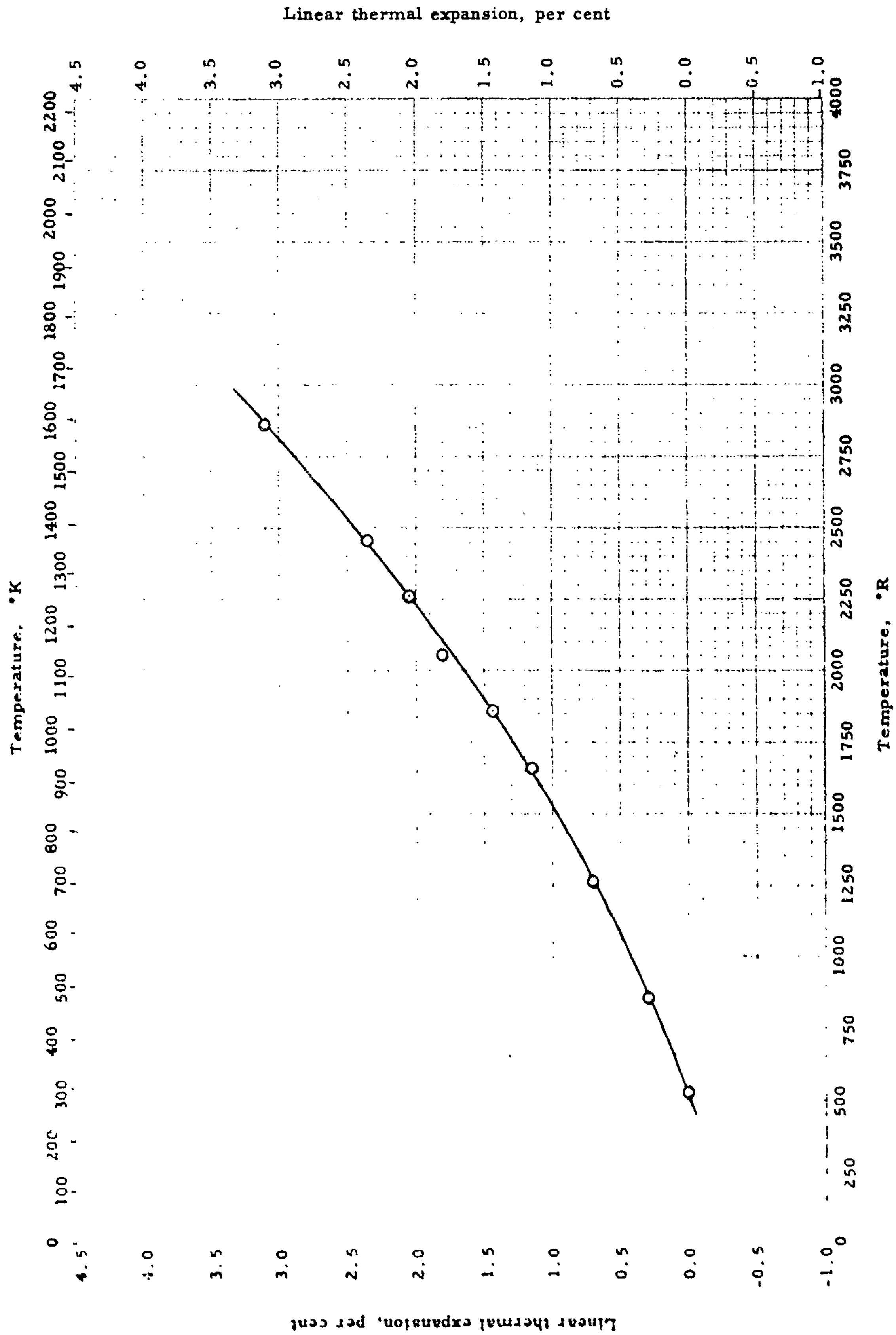
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	479.6	7.683
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF IRON + NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	Room	P 193 (German desig.): 38.5% - 42.1% Fe; 28.7% - 30.1% Ni; 25.4%-27.4% Cr; 1.88% - 1.97% Ti; 0.71%-0.93% Si; 0.69%-0.75% Mn; 0.45% C	ρ: not given	

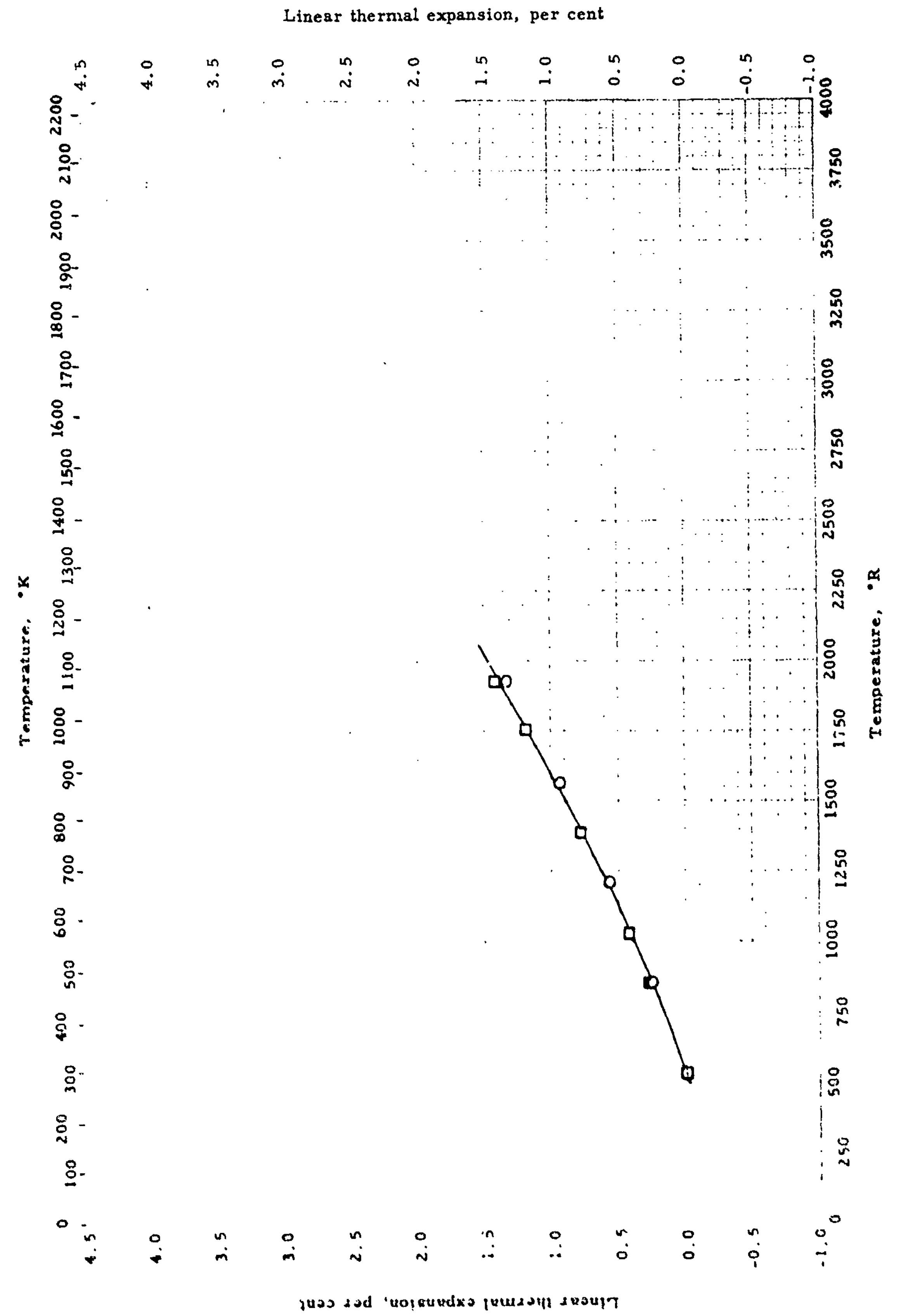


LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + MOLYBDENUM + X

LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Apblett, W. R., and Pellini, W. S.	51-5	530-2860	25.2% Ni; 16.3% Cr; 6.25% Mo; 1.68% Mn; 0.50% Si; 0.110% N_2; 0.10% C	Strain gages on channel-shaped clip fastened to pins welded on sample	Heating rate: 200 °F/sec.

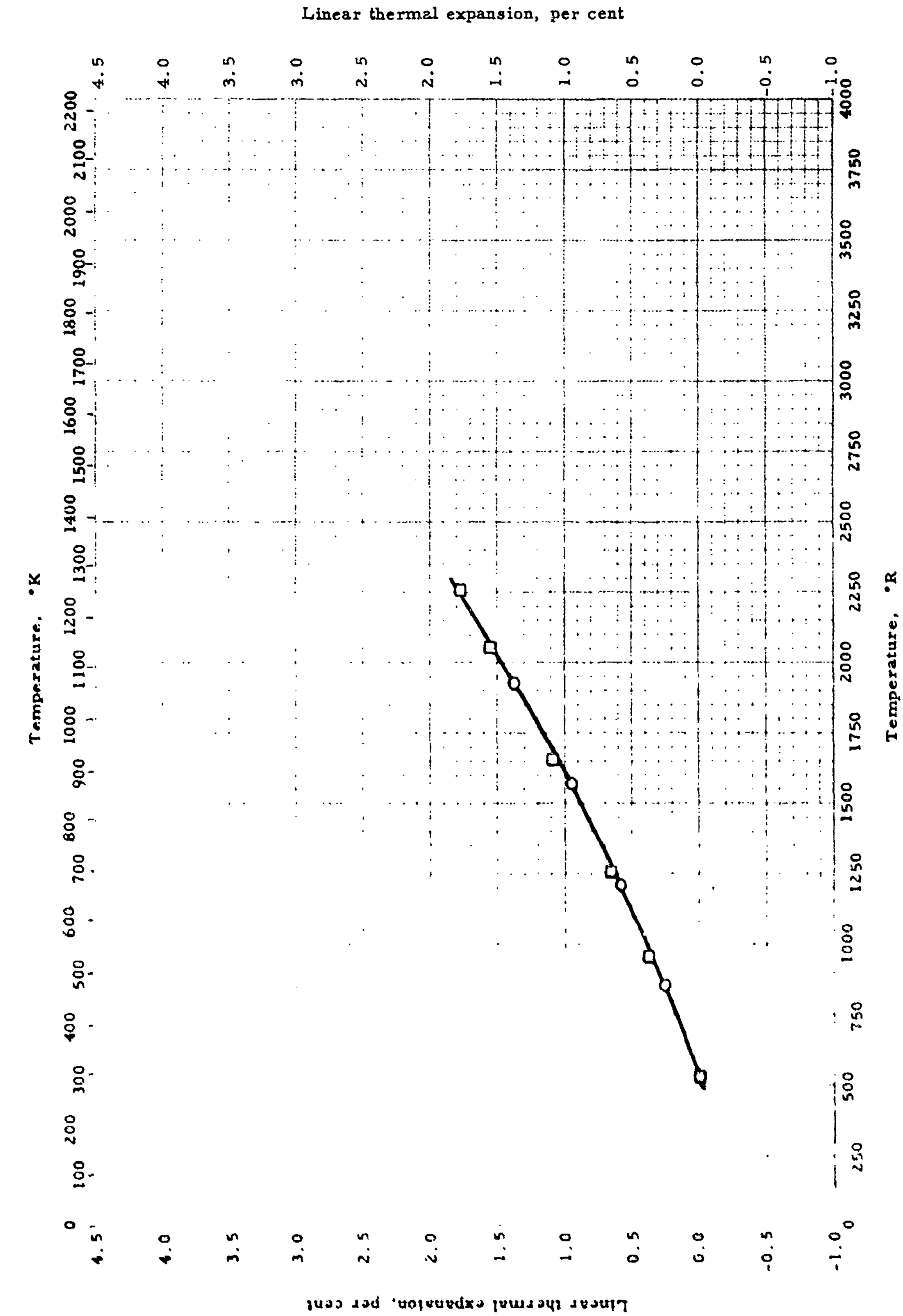


LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + TUNGSTEN + X

LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + TUNGSTEN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W., and Bollenrath, F.	47-8	852-1932	DVL 31 (Ger. Desig.); 27.1% Ni; 19.3% Cr; 11.2% W; 2.12% Si; 1.35% Mn; 0.17% C. ρ = 522.9 lb_m/ft^3	Dilatometer	Forged
□	Ibid.	47-8	852-1932	DVL 4/V 869 (Ger. Desig.); 24.9% Ni; 19.2% Cr; 6.6% W; 1.77% Ta, Nb; 1.73% Mn; 0.89% Si; 0.25% C. ρ = 519.3 lb_m/ft^3	Same as above	Forged, annealed at 1050°C air cooled

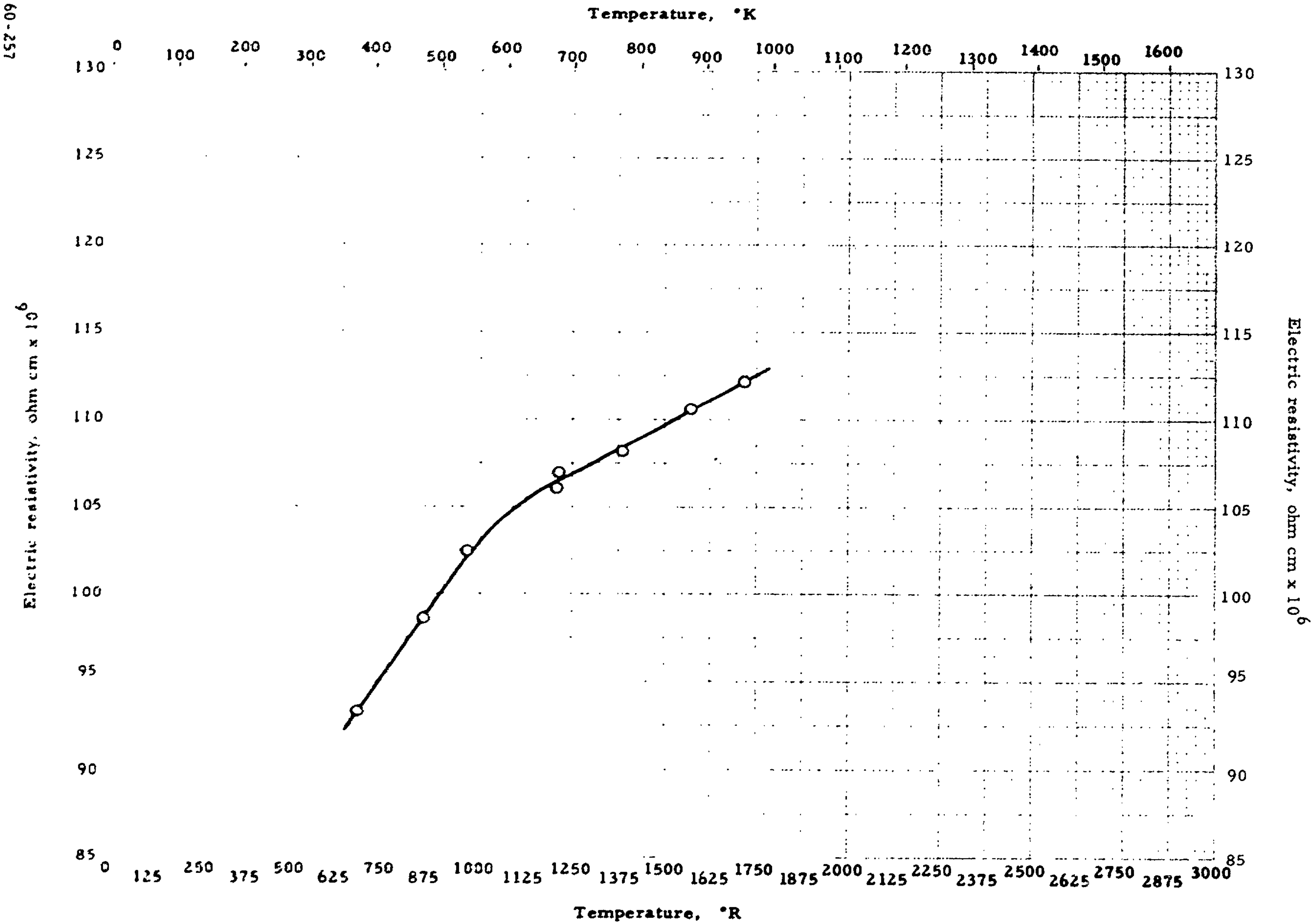


LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + X
(28 - 31% Ni; 25 - 28% Cr)

LINEAR THERMAL EXPANSION -- IRON + NICKEL + CHROMIUM + X
(28 - 31% Ni; 25 - 28% Cr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Cornelius, H., Bungardt, W. and Bollenrath, F	47-8	852-1932	P 193 (Ger. Desig.); 42.1 - 38.5% Fe; 28.7 - 30.1% Ni; 25.4 - 27.4% Cr; 1.97 - 1.88% Ti; 0.71 - 0.93% Si; 0.69 - 0.75% Mn; 0.45 - 0.45% C. ρ = 479.6 lb_m/ft^3	Dilatometer	
□	Saller, H. A. et al.	53-127	528-2260	75% AISI 310; 25% GE-62 Braze. Nominal: 38.40% Fe; 32.63% Ni; 23.75% Cr; 3.87% Si; <1.5% Mn; <0.19% C	Dilatometer, tested in vac. at 5.5°F/min.rise	Arc melted, cast, heated at 2260°R for 24 hr. in vac. Data average of two heating and cooling cycles

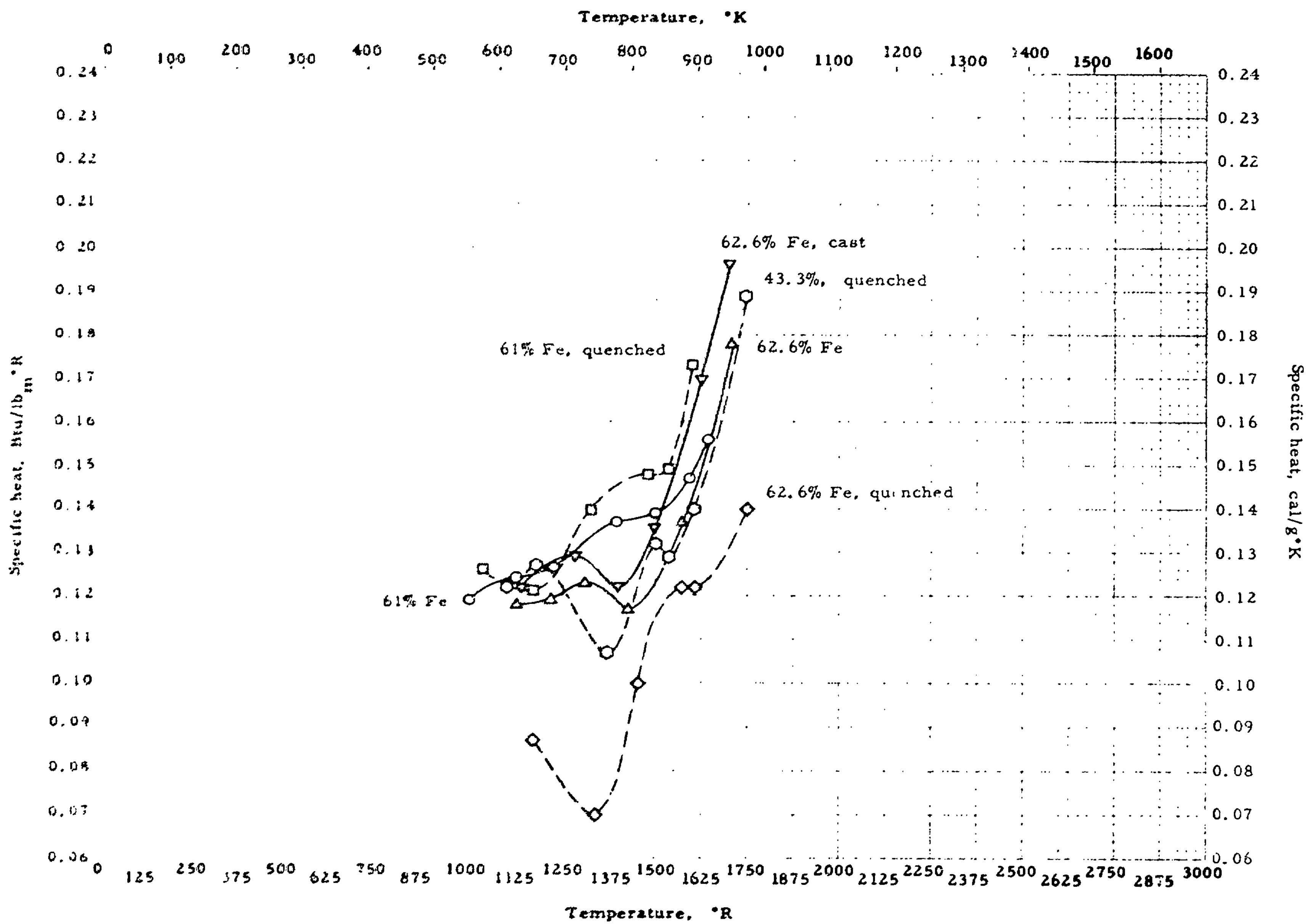


ELECTRIC RESISTIVITY -- IRON + NICKEL + CHROMIUM + X

ELECTRIC RESISTIVITY -- IRON + NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	[illegible], V. I. and [illegible], L. I.	57-117	671-1718	20% Ni; 20% Cr; 20% Co	Potential drop. Sample temp. by Chromel-Alumel thermocouple	Forged, quenched in oil from 1200 °C, aged 70 hr. at 760 °C. Auth. est. accuracy ± 1%

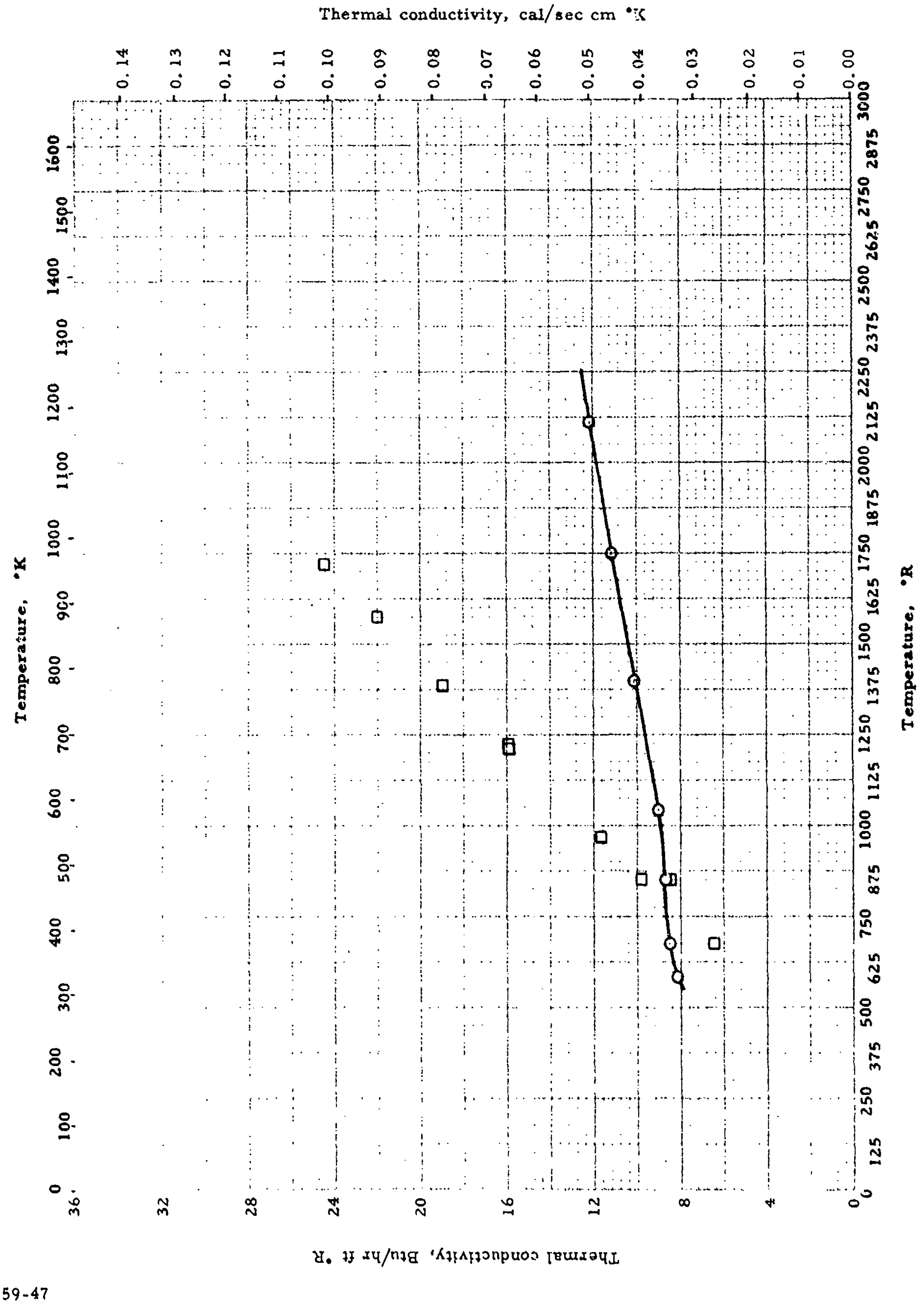


SPECIFIC HEAT -- IRON + NICKEL + ALUMINUM

SPECIFIC HEAT -- IRON + NICKEL + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Troshkina, V.A. and Khomyakov, K.G.	54-121	996-1644	60.98% Fe; 27.25% Ni; 11.77% Al	Rate of temp. rise of an insulated sample heated with constant source of known magnitude	Tempered in vacuum at 800° C for 18 hours followed by slow cooling (5°C/hr) to 400° C. Auth. est. accuracy ± 1.5%
□	Ibid	54-121	1032-1599	Same as above	Same as above	As above, followed by quenching from 620° C. Auth. est. accuracy ± 1.5%
△	Ibid	54-121	1122-1707	62.56% Fe; 24.79% Ni; 12.65% Al	Same as above	Tempered in vacuum at 800° C for 18 hours followed by slow cooling (5°C/hr) to 400° C. Auth. est. accuracy ± 1.5%
◇	Ibid	54-121	1167-1752	Same as above	Same as above	As above, followed by quenching from 1300° C. Auth. est. accuracy ± 1.5%
▽	Ibid	54-121	1140-1698	Same as above	Same as above	Cast. Auth. est. accuracy ± 1.5%
⬡	Ibid	54-121	1032-1743	43.28% Fe, 33.05% Ni; 23.67% Al	Same as above	Quenched from 1300° C, then soaked at 800° C for 5 hours, then quenched. Auth. est. accuracy ± 1.5%

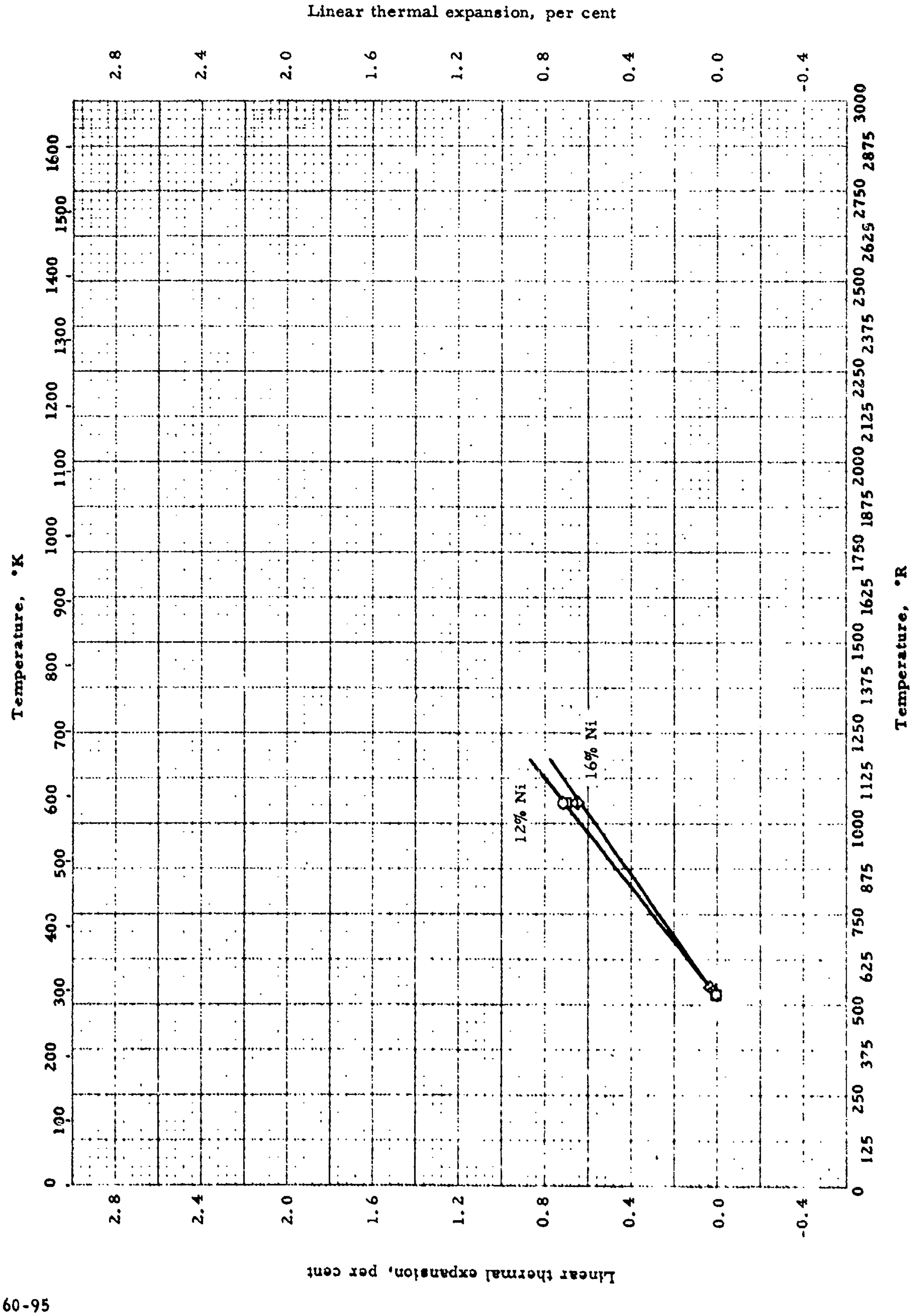


THERMAL CONDUCTIVITY -- IRON + NICKEL + COBALT + X

THERMAL CONDUCTIVITY -- IRON + NICKEL + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Silverman, L.	53-2	582-2112	Kovar. 53.7% Fe; 28.75% Ni; 17.15% Co; 0.47% Mn; 0.017% C	Comparative; rods	
□	Perova, V.I. and Knoroz, L.I.	57-117	671-1718	20% Ni; 20% Co; 20% Cr	Temp. distribution along resistance heated rod	Data probably too high

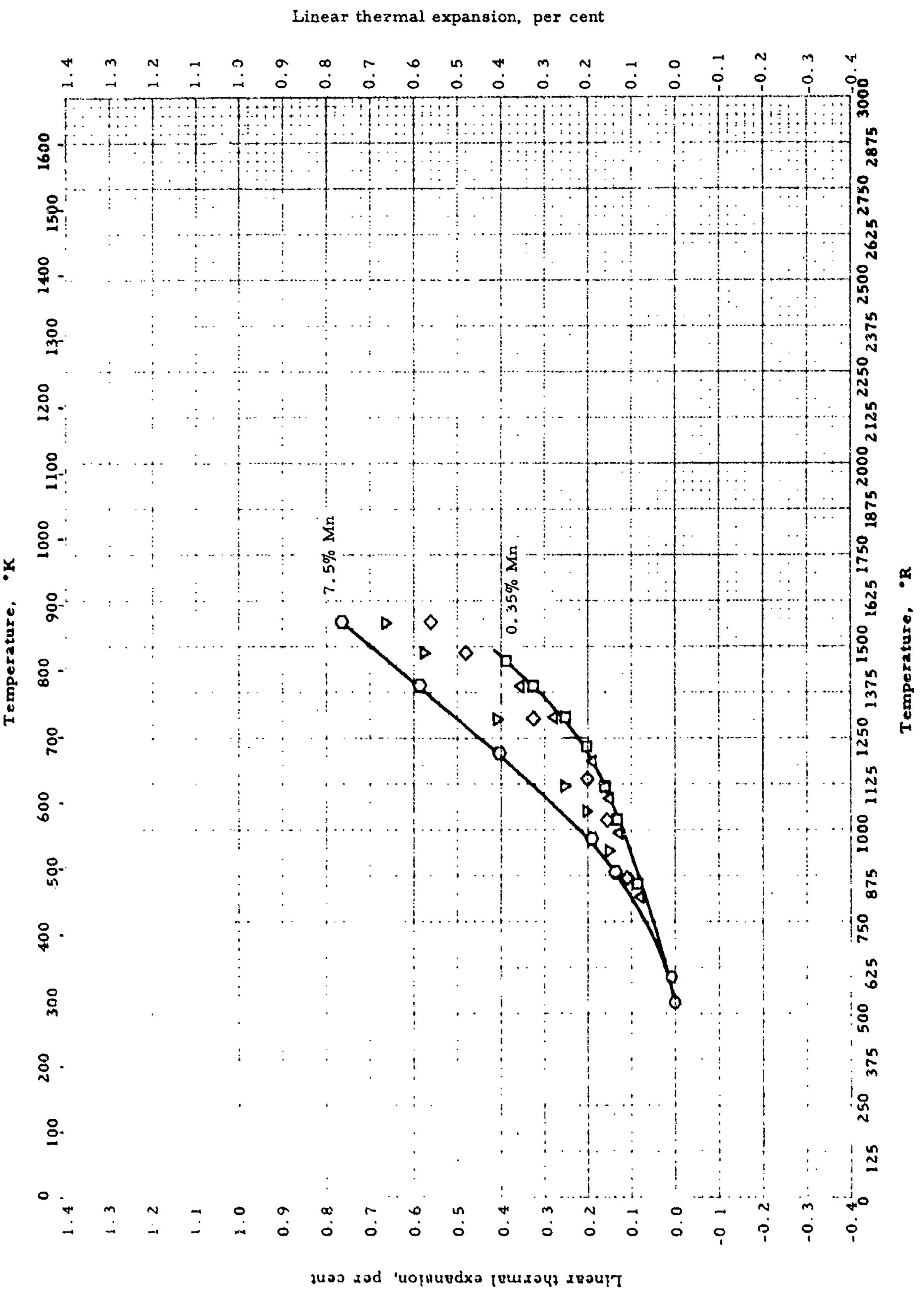


LINEAR THERMAL EXPANSION -- IRON + NICKEL + MANGANESE + X
(12 - 16% Ni; 5 - 9% Mn)

LINEAR THERMAL EXPANSION -- IRON + NICKEL + MANGANESE + X
(12 - 16% Ni; 5 -9% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Payson, P.	56-80	530-1060	Three Austenitic Steel Samples: a) 13.0% Ni; 9.2% Mn; 0.69% C; 0.13% Si; 0.01% Cr b) 12.1% Ni, 4.8% Mn; 0.71% Si; 0.61% C; 0.2% Cr c) 11.9% Ni; 4.9 % Mn; 0.50% C; 0.05% Si; 0.03% Cr	Not given	Air cooled from 2100°F. Auth. reports identical data for these samples
□	Ibid.	56-80	530-1060	15.8% Ni; 5.1% Mn; 0.61% Si; 0.58% C; 0.1% Cr	Same as above	Air cooled from 2100°F
△	Ibid.	56-80	530-1060	13.8% Ni; 5.0% Mn; 4.9% Cr; 0.58% C; 0.53% Si	Same as above	Same as above
◇	Ibid.	56-80	530-1060	16.1% Ni; 4.9% Mn; 3.4% Cr; 0.62% C; 0.59%Si	Same as above	Same as above

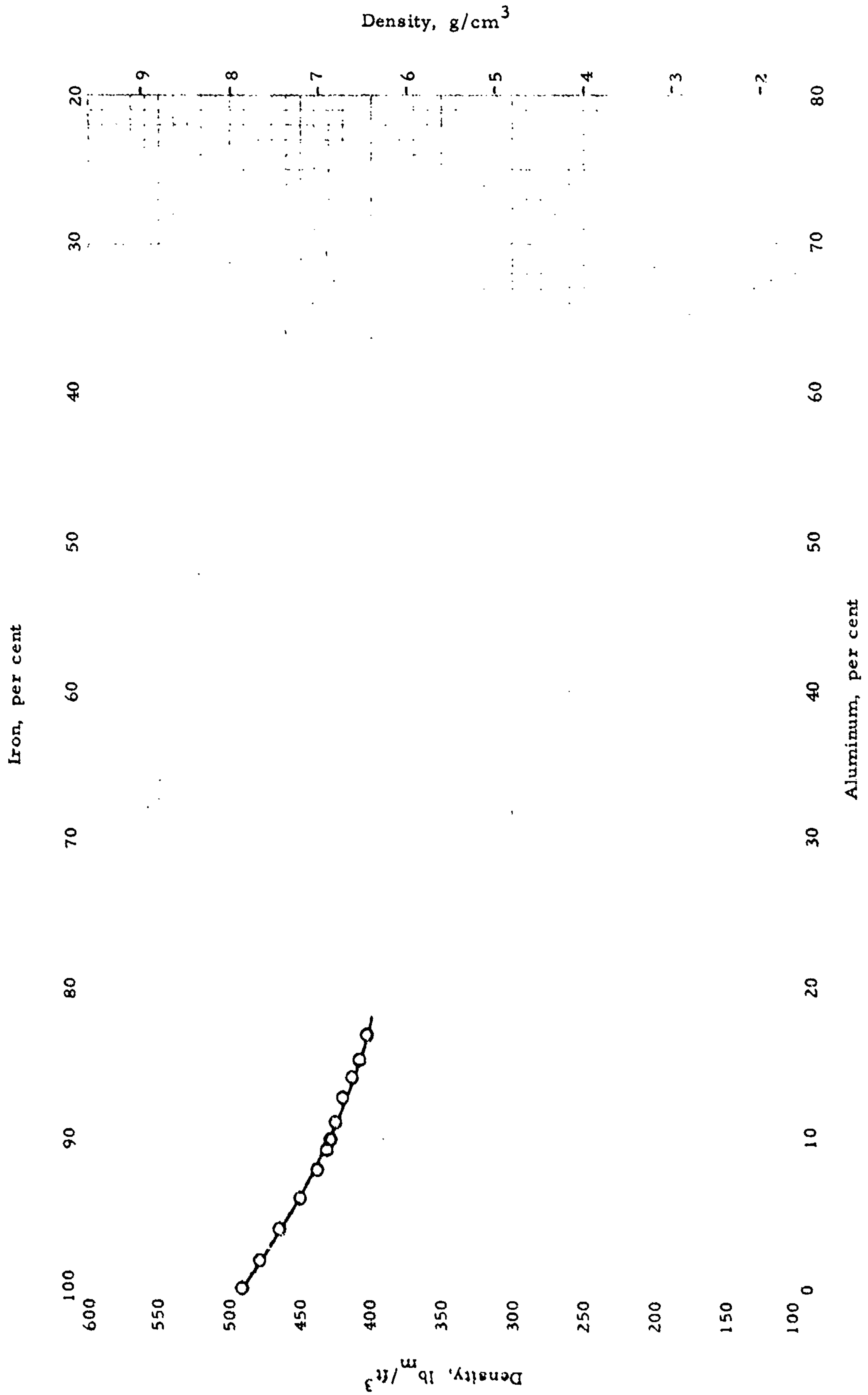


LINEAR THERMAL EXPANSION -- IRON + NICKEL + MANGANESE + X
(36-43% Ni; 0.3-8% Mn)

LINEAR THERMAL EXPANSION -- IRON + NICKEL + MANGANESE + X
(36-43% Ni; 0.3-8% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Rosenfield, A. R. and Averbach, B. E.	55-15	528-600	Invar: 36.4% Ni; 0.39% Mn; 0.09% Si; 0.08% C	Strain gages glued to sample	
□	Millner, T. and Welesz, R.	56-126	528-1464	56.4% Fe; 43.8% Ni; 0.35% Mn; 0.03% C	Chevenard differential dilatometer	Prepared from Swedish Armco Iron, electrolytic Ni + electrolytic Mn. Induction melted, cast and forged
△	Ibid.	56-126	528-1392	56.0% Fe; 43.8% Ni; 0.75% Mn; 0.02% C	Same as above	Same as above
◇	Ibid.	56-126	528-1572	55.7% Fe; 43.4% Ni; 1.98% Mn; 0.05% C	Same as above	Same as above
▽	Ibid.	56-126	528-1572	50.8% Fe; 43.0% Ni; 4.52% Mn; 0.03% C	Same as above	Same as above
○	Ibid.	56-126	528-1572	49% Fe; 43% Ni; 7.50% Mn; 0.04% C	Same as above	Same as above

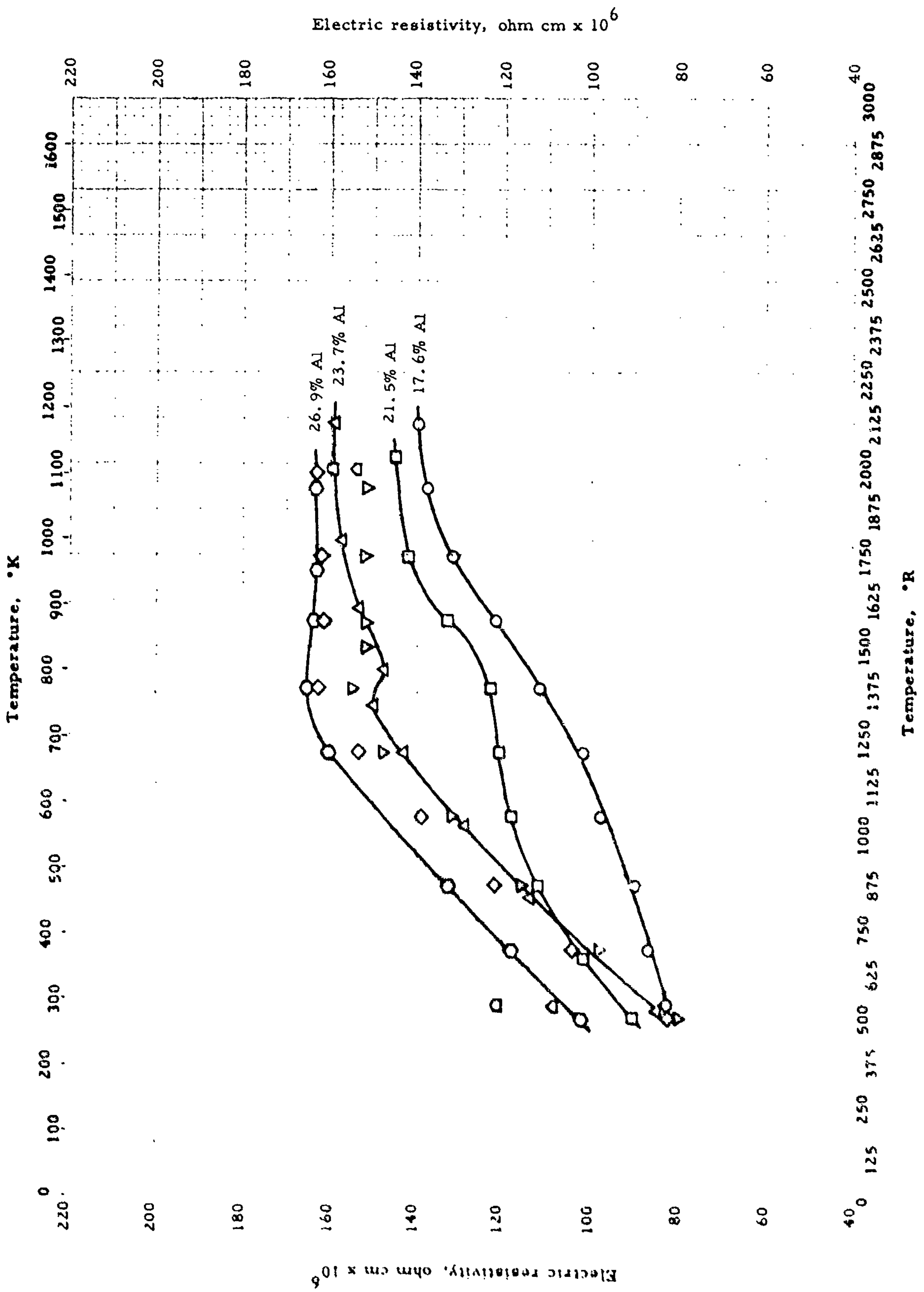


DENSITY -- IRON + ALUMINUM

DENSITY -- IRON + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Masumoto, H. and Saito, H	51-70	Room	0 - 17% Al	Weight in air and in water	Made from electrolytic Fe and Al. Forged, turned, annealed 1 hr at 1000° C, furnace cooled to 700° C, then cooled to room temperature at 30°/hr

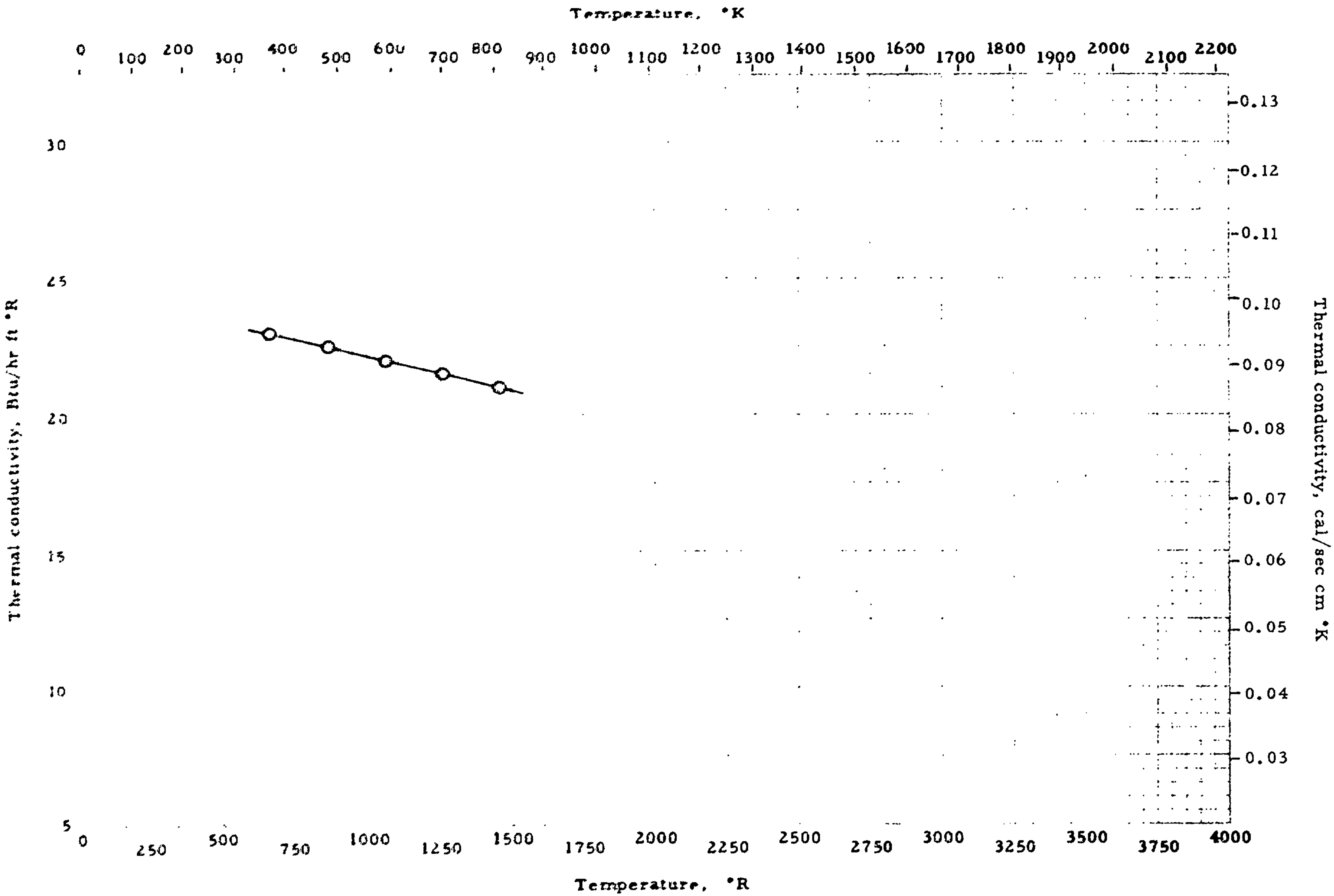


ELECTRIC RESISTIVITY -- IRON + ALUMINUM + X

ELECTRIC RESISTIVITY -- IRON + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bennett, W. D.	52-36	492-2112	82.4% Fe; 17.6% Al; prepared from 99.998% pure Al and spectrographically pure Fe	Potential drop	Results typical of samples both rapidly heated from quenched state and in equilibrium, slowly cooled
□	Ibid.	52-36	492-2022	78.5% Fe; 21.5% Al; raw materials same as above	Same as above	Sample in equilibrium, slowly cooled. Also reports values for quenched sample
△	Ibid.	52-36	492-2112	76.3% Fe; 23.7% Al; raw materials same as above	Same as above	Same as above
◇	Ibid.	52-36	492-1932	75.5% Fe; 24.5% Al; raw materials same as above	Same as above	Same as above
▽	Ibid.	52-36	492-1932	74.2% Fe; 25.8% Al; raw materials same as above	Same as above	Same as above
○	Ibid.	52-36	492-1752	73.1% Fe; 26.9% Al; raw materials same as above	Same as above	Same as above
◻	Thomas, H.	50-31	528-1932	87.7% Fe; 10.2% Al; 2.1% Cr	Resistivity measured in a self registering photographic device	Annealed
⌂	Ibid.	50-31	528-1932	10.8% Al	Same as above	Annealed

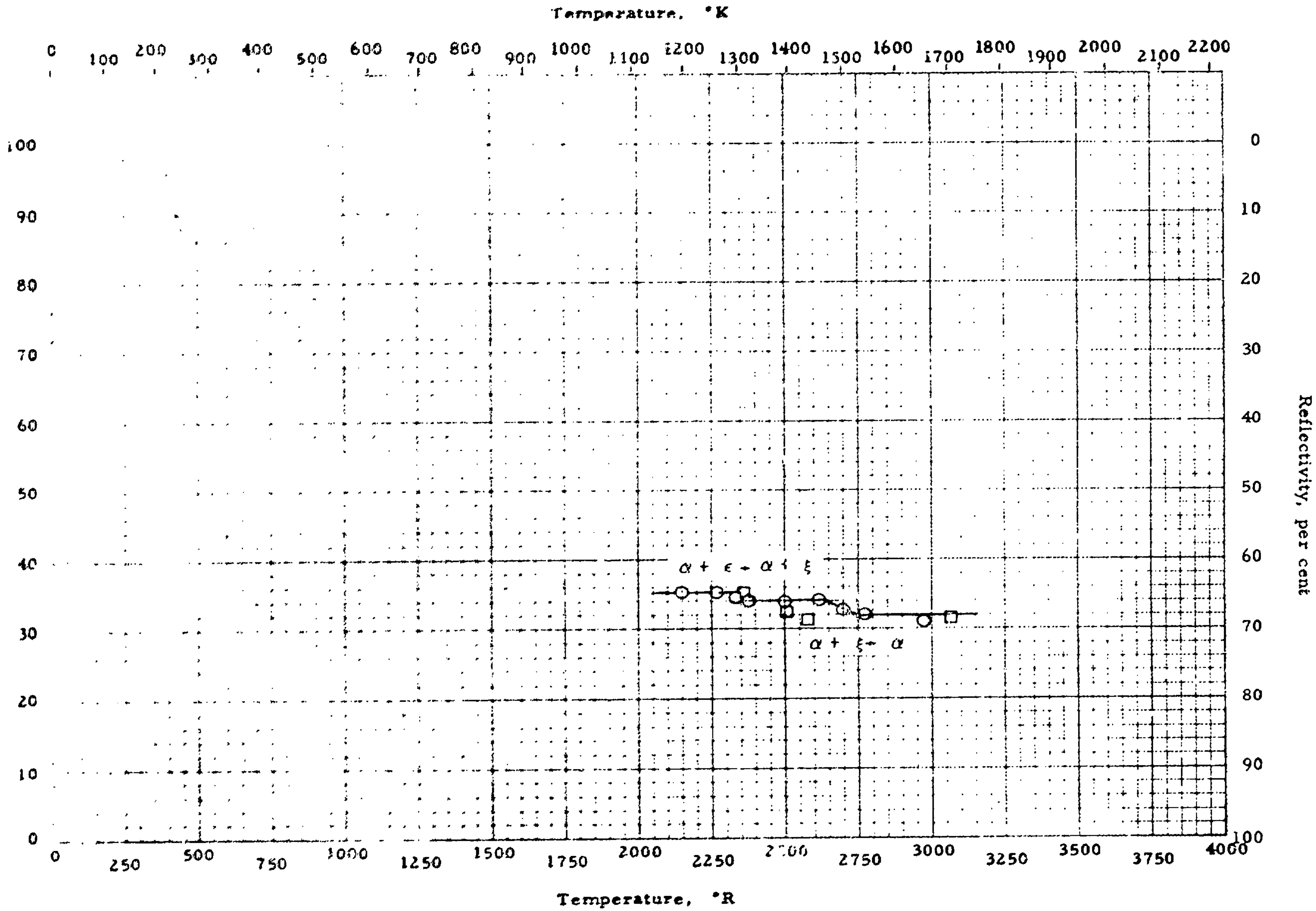


THERMAL CONDUCTIVITY -- IRON + TUNGSTEN + CHROMIUM

THERMAL CONDUCTIVITY -- IRON + TUNGSTEN + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Loewen, E. G.	56-21	660-1460	High speed steel (Ti); 77% Fe; 18% W; 4% Cr; 1% V	Axial heat flow in rod; calorimeter sink; guarded	Annealed. Auth. est. accuracy ± 7 - 10%



EMISSIVITY -- IRON + TUNGSTEN

EMISSIVITY -- IRON + TUNGSTEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Knop Jr., H. W.	48-6	2160-2370	18% W. Held 1 week at 1375°K. Hence at initial condition alloy consists of $\alpha + \epsilon$ phases	Spectral emissivity at 0.667 micron: comparative: surface brightness compared with that of a black body hole; calibrated disappearing filament optical pyrometer	Alloy prepared electrolytically. Average of 2 runs
□	Ibid.	48-6	2340-3060	18% W. Held at 1680°K, hence at initial condition alloy consists of α-solid solution	Same as above	Same as above. Data taken during cooling

PROPERTIES OF IRON + MANGANESE + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 20% Mn	480 lb_m/ft^3	7.7 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3
○	478.2	7.660
□	478.3	7.661
△	485.8	7.786
◇	486.0	7.789

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

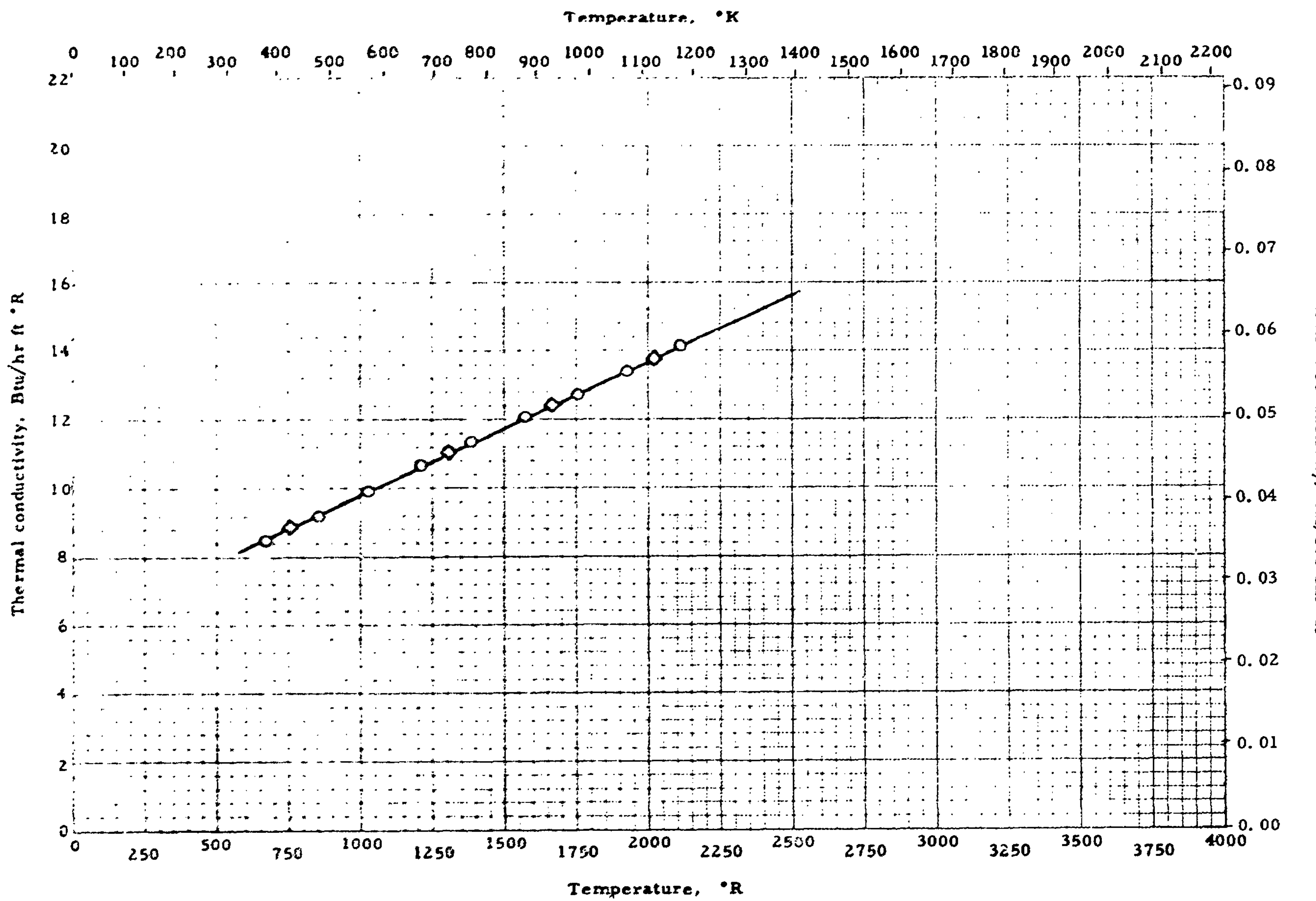
Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF IRON + MANGANESE + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref	Range, °R	Material Composition	Test Method	Remarks
○	Neumark, B. E.	55-68	Room	19.96% Mn; 12.05% Cr; 0.83% Si; 0.51% V; 0.26% C	ρ: weight in air and in water	Stabilized 10 hr. at 800° C. Auth. est. accuracy ± 0.2%
□	Ibid.	55-68	Room	20.88% Mn; 14.66% Cr; 0.66% Si; 0.25% Ti; 0.05% C	ρ: same as above	Same as above
△	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	Room	German desig. 815: 16% Mn; 12% Cr; 0.3% ea. Si, Ti; 0.12% C	ρ: not given	Forged
◇	Ibid.	47-8	Room	German desig. FCM: 63.7 - 67.2% Fe; 15.9 - 16.5% Mn; 15.0 - 15.8% Cr; 0 - 2.1% Mo; 0.9 - 1.25% Ni; 0.30 - 1.07% Si; 0.15 - 0.17% C	ρ: not given	Rolled

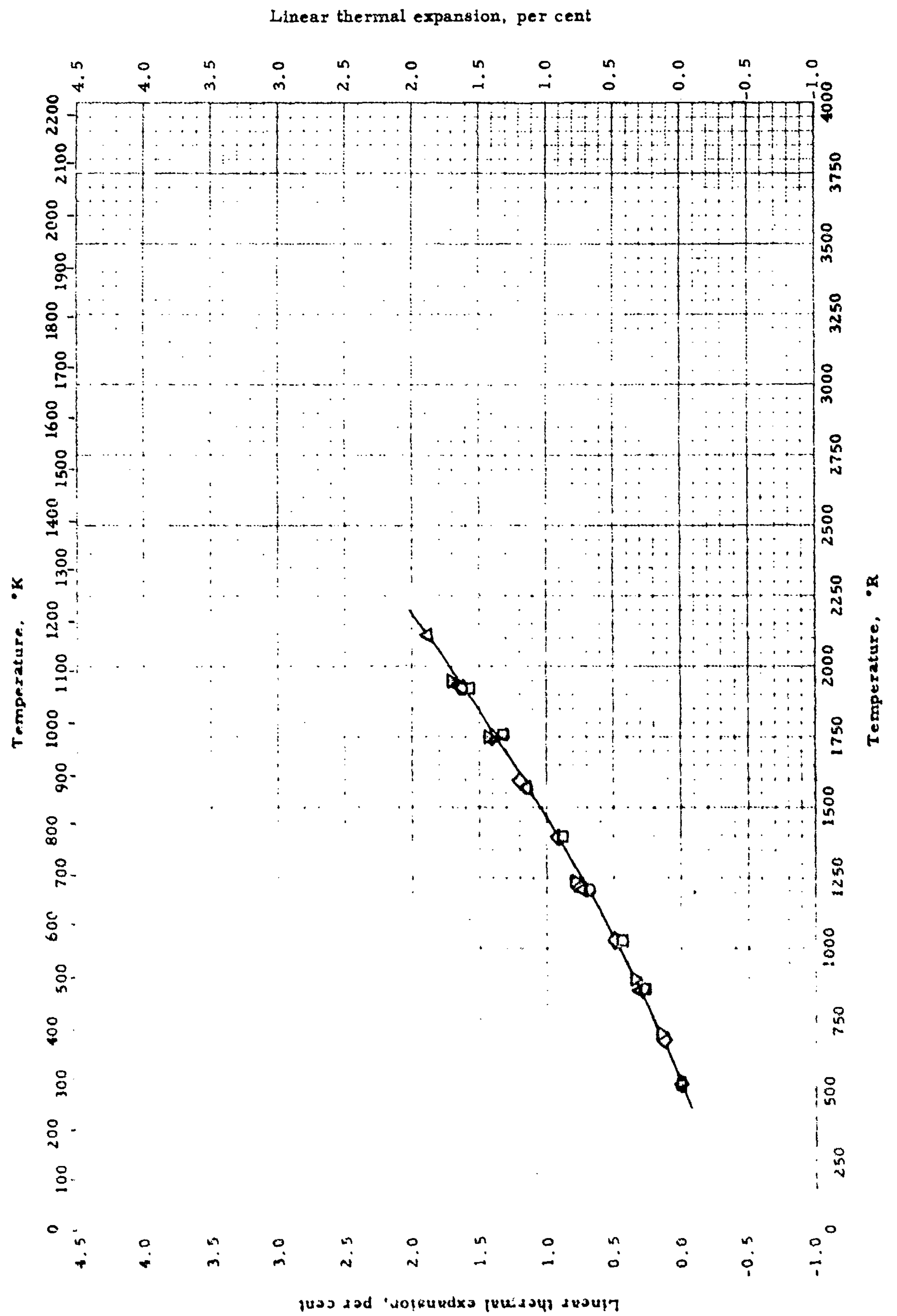


THERMAL CONDUCTIVITY -- IRON + MANGANESE + CHROMIUM + X

THERMAL CONDUCTIVITY -- IRON + MANGANESE + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Neimark, B. E.	55-68	672-1932	19.96% Mn; 12.05% Cr; 0.83% Si; 0.51% V; 0.26% C	Temp. distribution along resistance heated rod	Stabilized at 1932°R for 10 hr.
◇	Ibid.	55-68	672-2112	20.88% Mn; 14.66% Cr; 0.66% Si; 0.25% Ti; 0.05% C	Same as above	Same as above

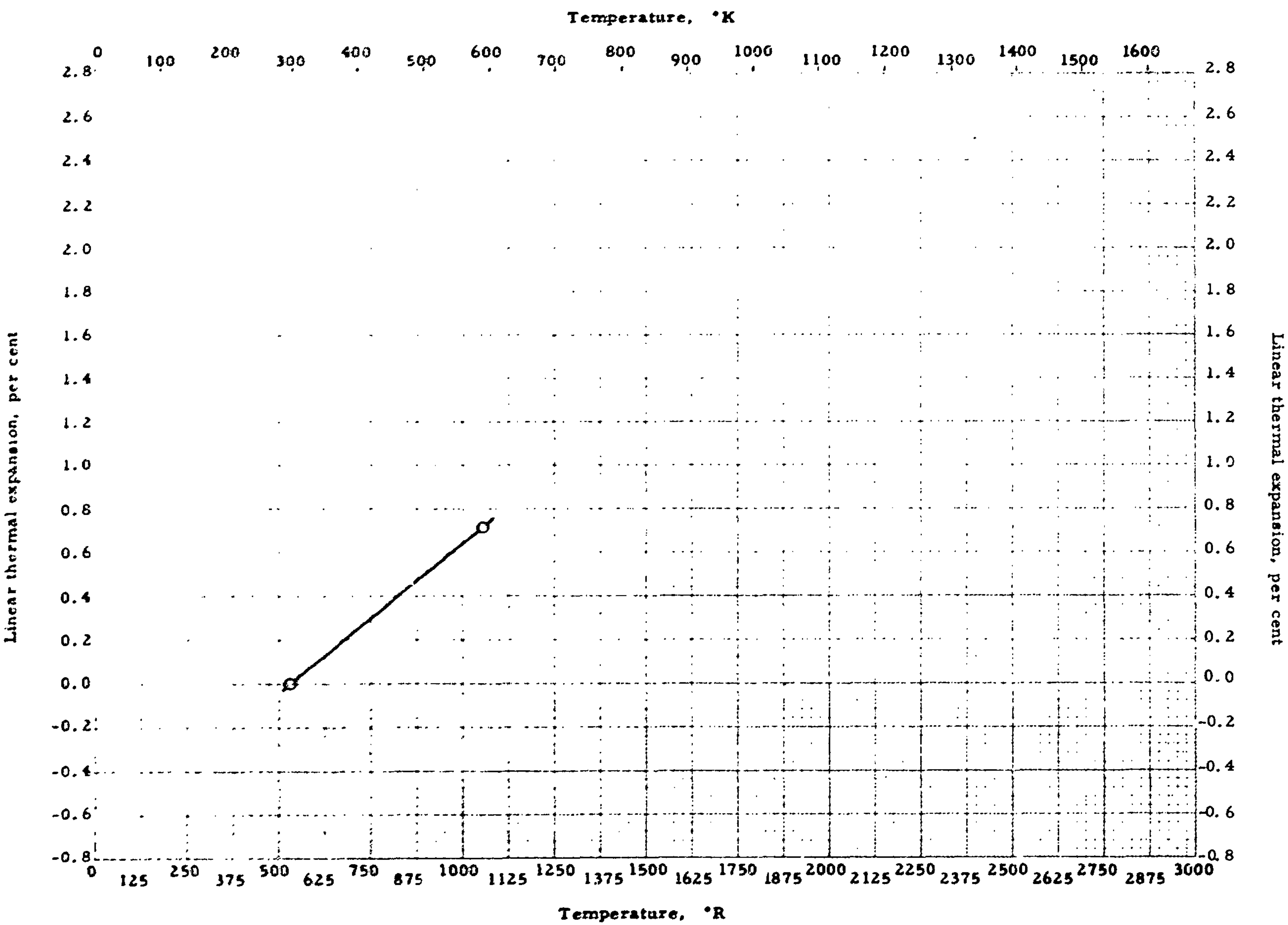


LINEAR THERMAL EXPANSION -- IRON + MANGANESE + CHROMIUM + X

LINEAR THERMAL EXPANSION -- IRON + MANGANESE + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W., and Bolenrath, F.	47-8	852-1932	815 (Ger. design.) 71.3% Fe; 16% Mn; 12% Cr; 0.3% Si; 0.3% Ti; 0.12% C $\rho = 485.8\ lb_m/ft^3$	Bollenrath type comparative dilatometer	Forged
□	Ibid.	47-8	852-1932	FCM (Ger. design.) 63.7 - 67.2% Fe; 15.9 - 16.5% Mn; 15.8 - 15.0% Cr; 2.1 - 0% Mo; 1.25 - 0.9% Ni; 1.07 - 0.30% Si; 0.17 - 0.15% C $\rho = 486.0\ lb_m/ft^3$	Same as above	Rolled
△	Cornelius, H.	43-17	528-2112	17-19% Mn; 10-13% Cr; 0.5-1.0% Si; 0.3% Ti; <0.14% C	Bollenrath type comparative dilatometer	Tested in vacuum at 1.5°C/min. rise
◇	Neimark, B. E.	55-68	528-1752	19.96% Mn; 12.05% Cr; 0.83% Si; 0.51% V; 0.26% C	Quartz tube dilatometer	Stabilized 10 hr. at 800°C. Tested at 2°C/min. rise
▽	Ibid.	55-68	528-1932	20.88% Mn; 14.66% Cr; 0.66% Si; 0.25% Ti; 0.05% C	Same as above	Same as above

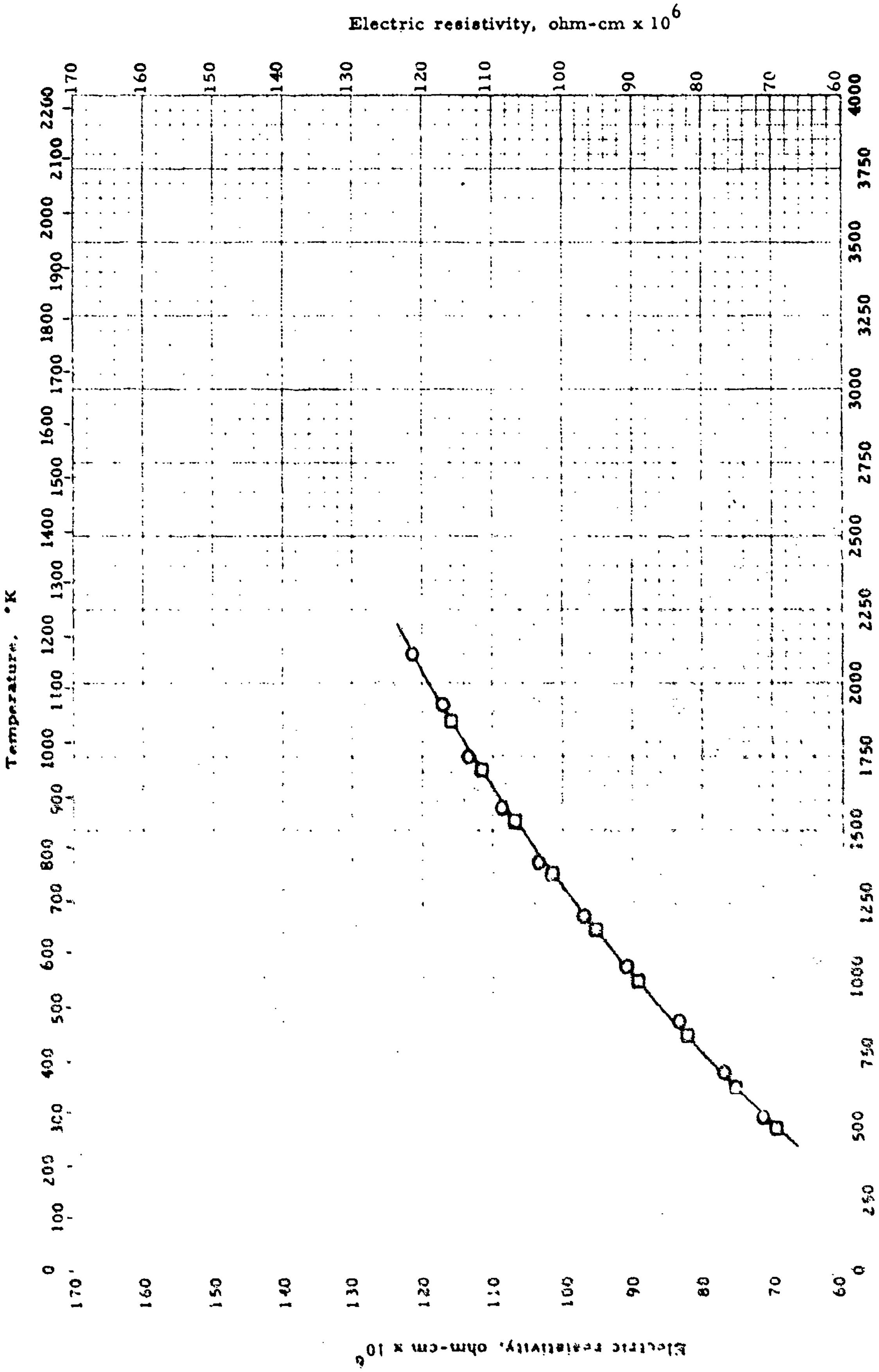


LINEAR THERMAL EXPANSION -- IRON + MANGANESE + NICKEL + X

LINEAR THERMAL EXPANSION -- IRON + MANGANESE + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Payson, P.	56-80	530-1060	Austenitic Steel, three samples: a) 13.6% Mn; 12.9% Ni; 0.73% C; 0.16% Si;0.00% Cr b) 12.9% Mn; 6.0% Ni; 0.68% C; 0.13% Si; 0.02% Cr c) 12.8% Mn; 9.0% Ni; 0.66% C; 0.18% Si; 0.02% Cr	Not given	Air cooled from 2100°F. Auth. reports identical data for three samples

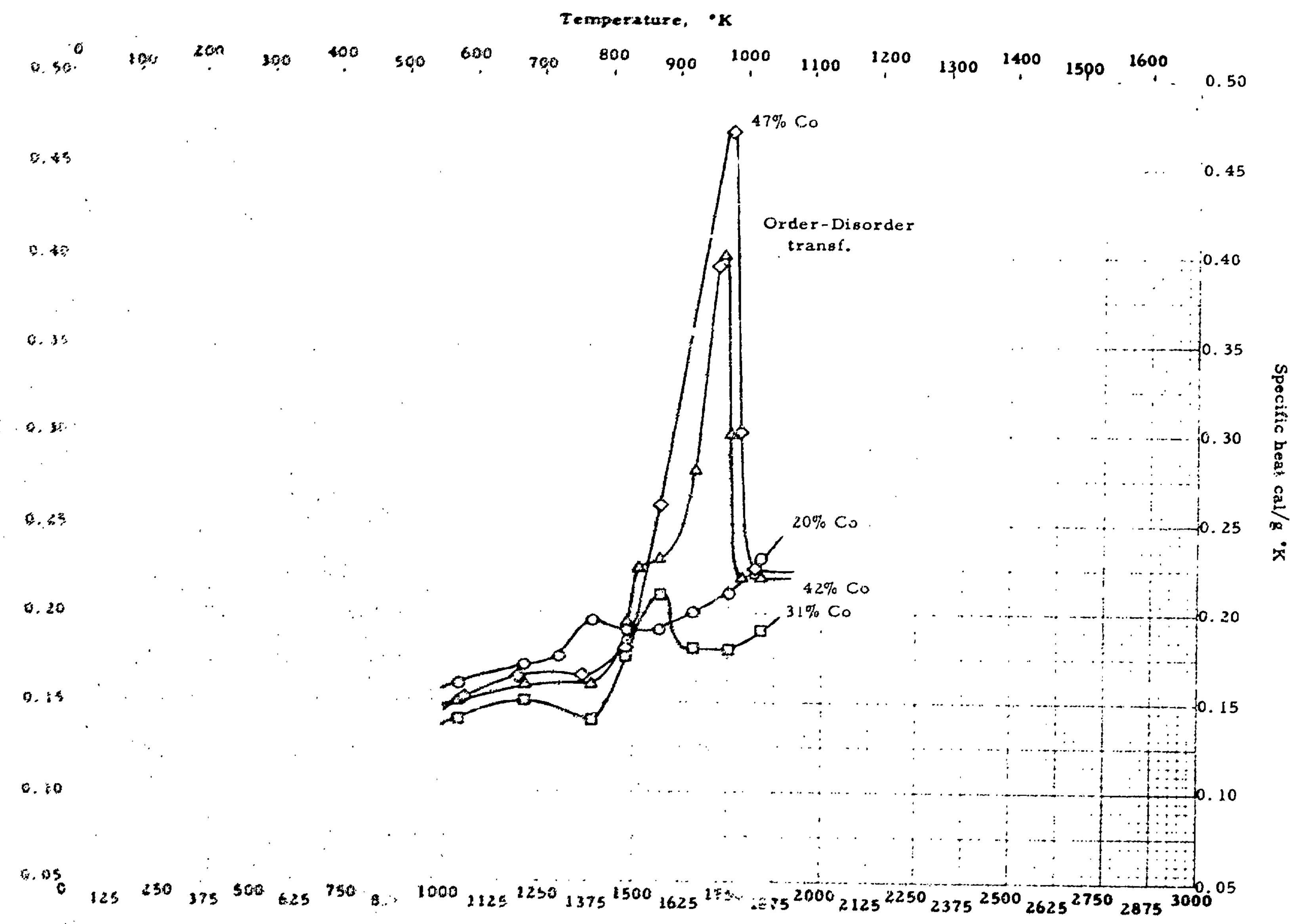


ELECTRIC RESISTIVITY -- IRON + MANGANESE + CHROMIUM + X

ELECTRIC RESISTIVITY -- IRON + MANGANESE + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Neimark, B.E.	55-68	528-2112	Alloy steel: 20.88% Mn; 14.66% Cr; 0.66% Si; 0.25% Ti; 0.05% C	Potential drop	Stabilized at 800°C for 10 hr.
□	Ibid.	55-68	528-2112	19.96% Mn; 12.05% Cr; 0.83% Si; 0.51% V; 0.26% C	Same as above	Same as above

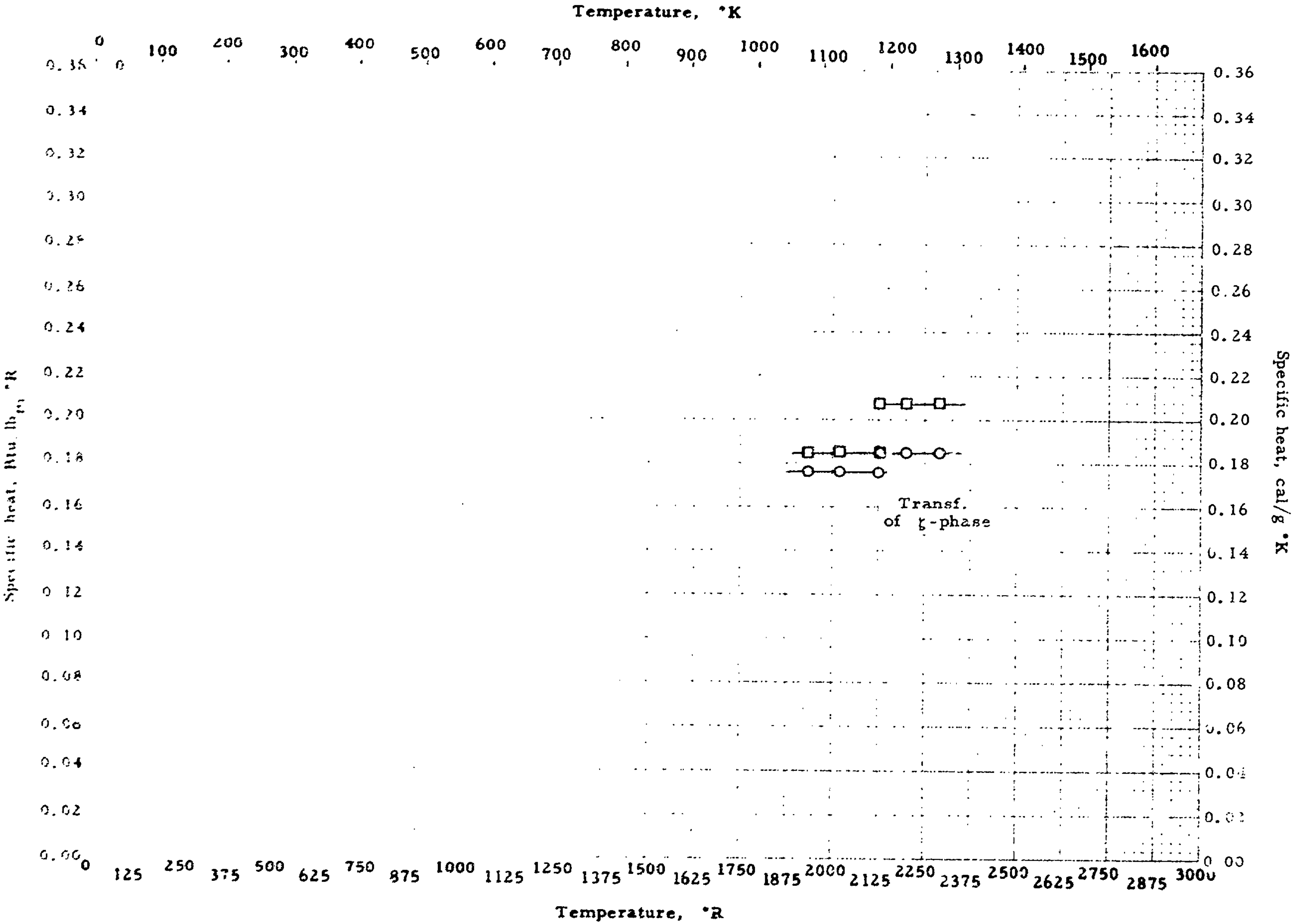


SPECIFIC HEAT -- IRON + COBALT + X

SPECIFIC HEAT -- IRON + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Masumoto, H., Saito, H. and Shirozaki, M.	54-118	1032-1842	30% Fe; 20% Co	Rate of cooling of sample compared with that of standard	Melted in H_2 from electrolytic Co and Fe. Forged, machined, annealed in vacuum 2 hr. at 1000 °C, cooled to 420 °C at 30 °C/hr. held 10 days at 420 °C, cooled to room temp. at 30 °C/hr
□	Ibid.	54-118	1032-1842	69% Fe; 31% Co	Same as above	Same as above
△	Ibid.	54-118	1032-1842	58% Fe; 42% Co	Same as above	Same as above
◇	Ibid.	54-118	1032-1842	53% Fe; 47% Co	Same as above	Same as above

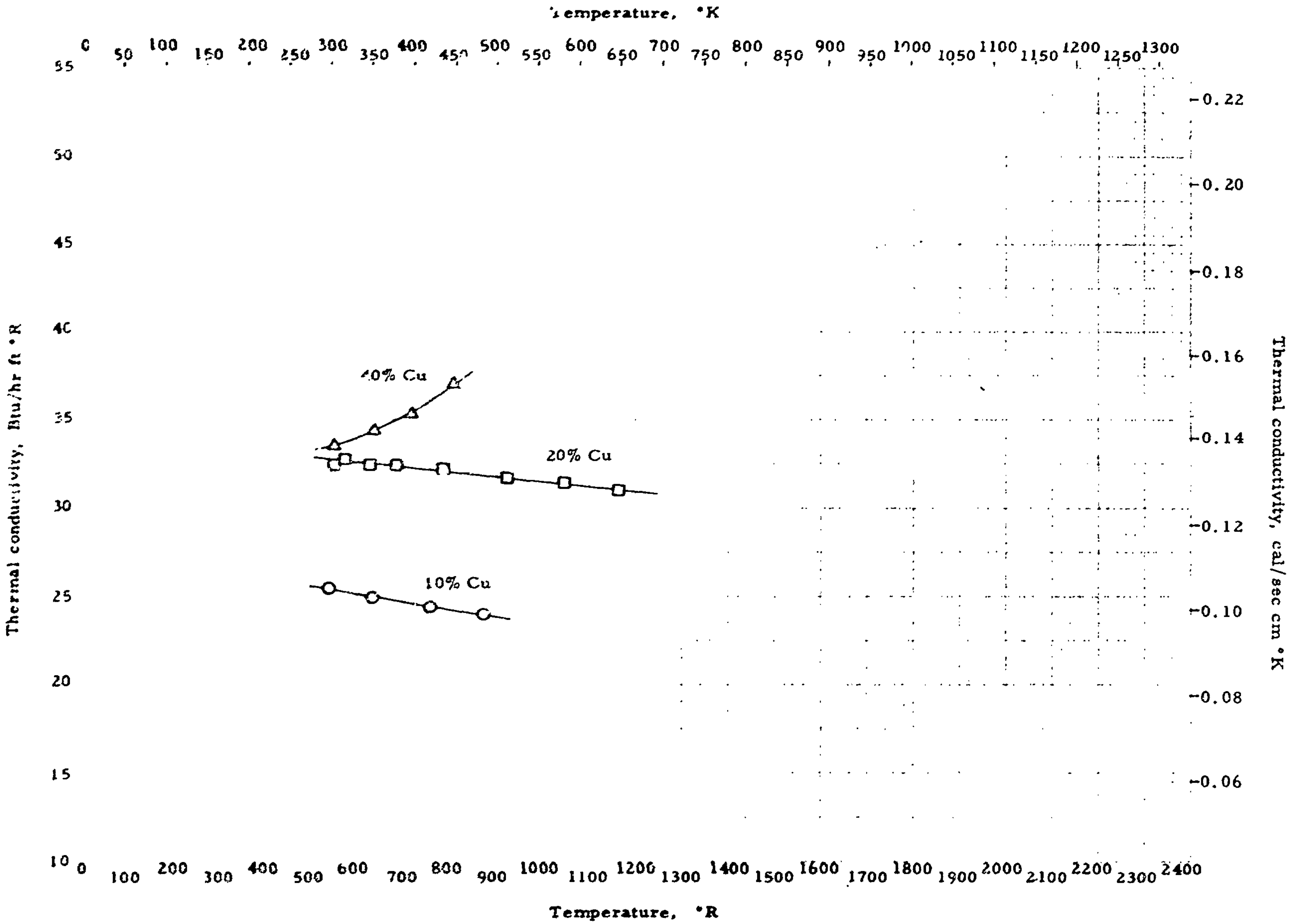


SPECIFIC HEAT -- IRON + SILICON

SPECIFIC HEAT -- IRON + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Serebrennikov, N. N., and Gel'd, P. V.	54-67	1932-2292	36.42% Si; prepared from Armco Iron and 99.2% Si	Drop method; copper block calorimeter	Annealed 3 hr. at 700 °C
□	Ibid.	54-67	1932-2292	44.46% Si	Same as above	Same as above

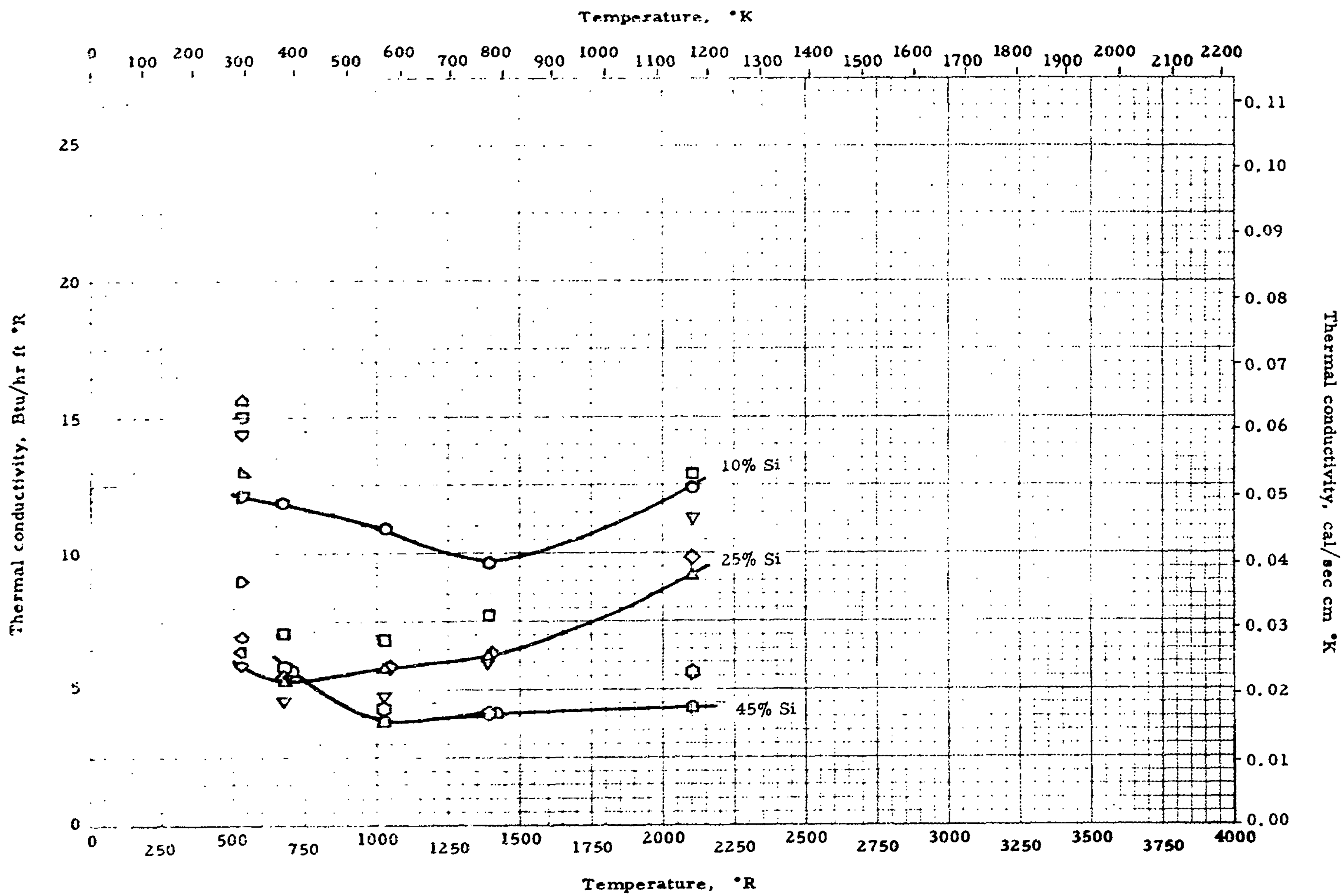


THERMAL CONDUCTIVITY -- POROUS IRON + COPPER + GRAPHITE ANTI-FRICTION ALLOYS

THERMAL CONDUCTIVITY -- POROUS IRON + COPPER + GRAPHITE ANTI-FRICTION ALLOYS

REFERENCE INFORMATION

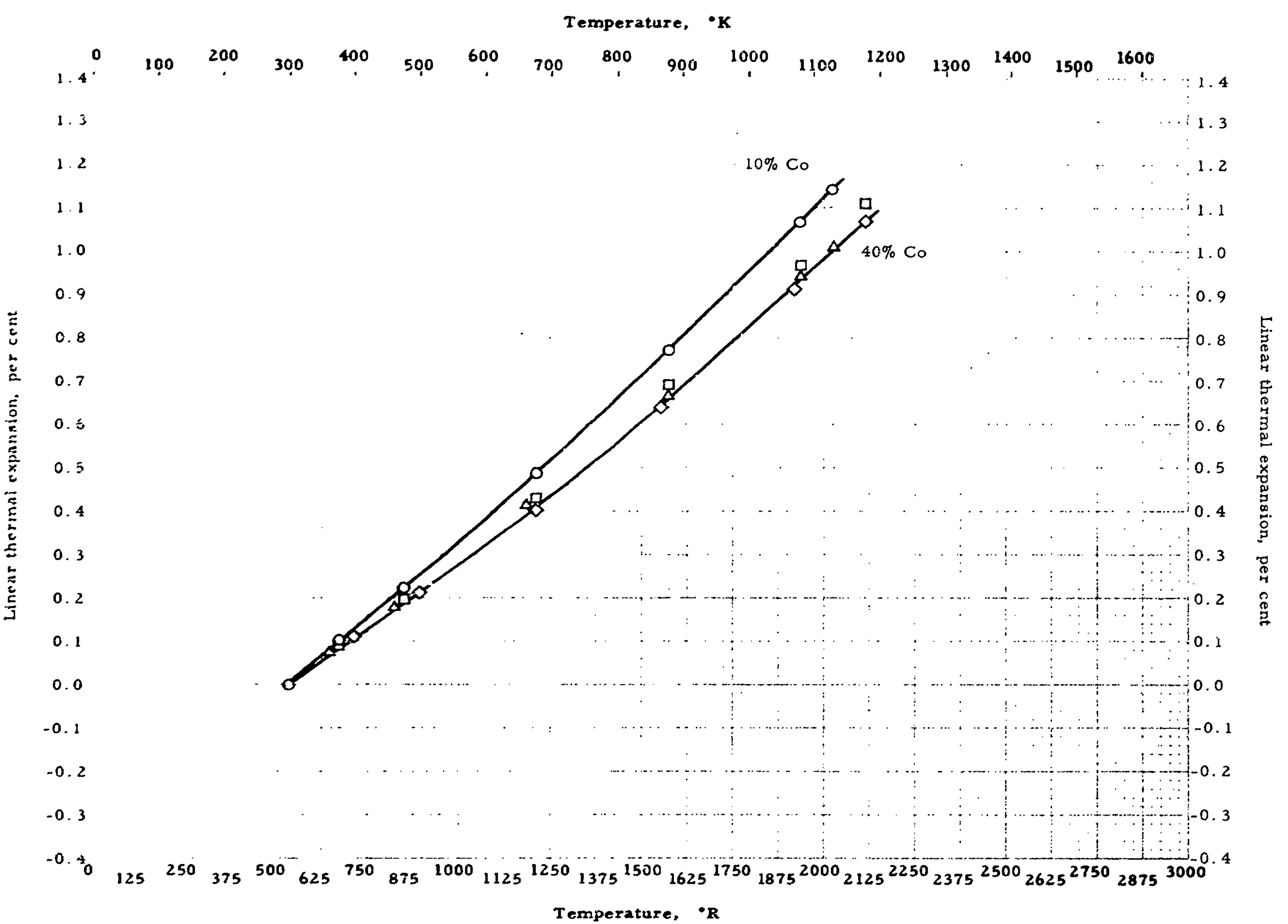
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E., and Pozdnyak, N. Z.	54-50	537-879	86.26% Fe; 10.54% Cu; 1.6% C; 0.42% Mn; 0.29% Si; porosity 10%. ρ = 465 lb_m/ft^3	Temp. distribution along resistance heated rod	Sintered 1.5 hr. at 1150°C in H_2 atmos.
□	Ibid.	54-50	548-1163	76.80% Fe; 19.86% Cu; 1.52% C; 0.39% Mn; 0.31% Si; porosity 10.5%. ρ = 479 lb_m/ft^3	Same as above	Same as above
△	Ibid.	54-50	548-807	56.15% Fe; 40.69% Cu; 1.51% C; 0.40% Mn; 0.29% Si; porosity 10.7%. ρ = 488 lb_m/ft^3	Same as above	Same as above



THERMAL CONDUCTIVITY -- IRON + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovsky, B. B. and Gel'd, P. V.	56-106	672-2112	90% Fe; 10% Si	Radial heat flow in thick-walled cylinder	Auth. est. accuracy ± 7%
□	Ibid.	56-106	672-2112	84% Fe; 16% Si	Same as above	Same as above
△	Ibid.	56-106	672-2112	75% Fe; 25% Si	Same as above	Same as above
◇	Ibid.	56-106	672-2112	71% Fe; 29% Si	Same as above	Same as above
▽	Ibid.	56-106	672-2112	68% Fe; 32% Si	Same as above	Same as above
○	Ibid.	56-106	672-2112	62% Fe; 38% Si	Same as above	Same as above
◠	Ibid.	56-106	672-2112	55% Fe; 45% Si	Same as above	Same as above
△	Glaser, F. W. and Ivanick, W.	56-122	Room	90.0% Fe; 10.0% Si	"Measured by heating one end and cooling other"	"Ordered" alloy. Powders pressed, homogenized 6 - 12 hr. at 2562°R
□	Ibid.	56-122	Room	85.0% Fe; 15.0% Si	Same as above	Same as above
▽	Ibid.	56-122	Room	82.5% Fe; 17.5% Si	Same as above	Same as above
△	Ibid.	56-122	Room	80.0% Fe; 20.0% Si	Same as above	Same as above
◇	Ibid.	56-122	Room	75.0% Fe; 25.0% Si	Same as above	Same as above
▷	Ibid.	56-122	Room	90.0% Fe; 10.0% Si	Same as above	"Disordered" alloy. Powders pressed, homogenized 6 - 12 hr. at 2562°R
▷	Ibid.	56-122	Room	85.0% Fe; 15.0% Si	Same as above	Same as above
◇	Ibid.	56-122	Room	80.0% Fe; 20.0% Si	Same as above	Same as above
◁	Ibid.	56-122	Room	75.0% Fe; 25.0% Si	Same as above	Same as above

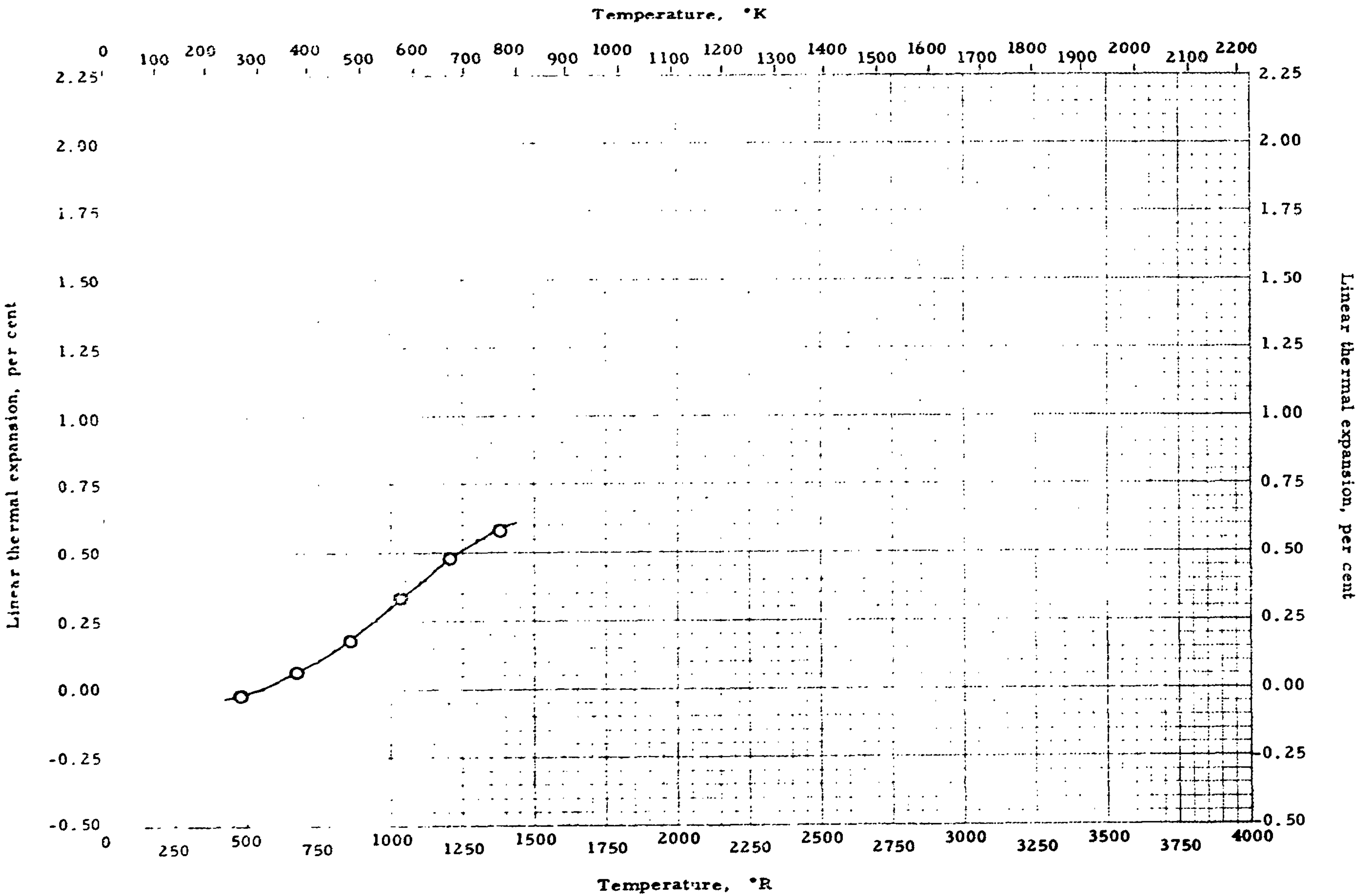


LINEAR THERMAL EXPANSION -- IRON + COBALT + X

LINEAR THERMAL EXPANSION -- IRON + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fine, M. E. and Ellis, W. C.	48-21 also 48-22	852-2022	89.4% Fe; 10.2% Co; 0.31% Mn; <0.01% Si	Quartz tube dilatometer. Tested at 200°C/hr. rise	Induction melted in vacuum, from Armco Iron and cobalt rondelles. Swaged, annealed 1 hr. at 900°C in H_2 atm., cooled slowly
□	Ibid.	48-21 also 48-22	852-2112	79.2% Fe; 20.0% Co; 0.47% Mn; Nil Si	Same as above	Same as above
△	Ibid.	48-21 also 48-22	852-2022	69.4% Fe; 30.2% Co; 0.45% Mn; Nil Si	Same as above	Same as above
◇	Ibid.	48-21 also 48-22	852-2112	59.4% Fe; 40.1% Co; 0.44% Mn; Nil Si	Same as above	Same as above

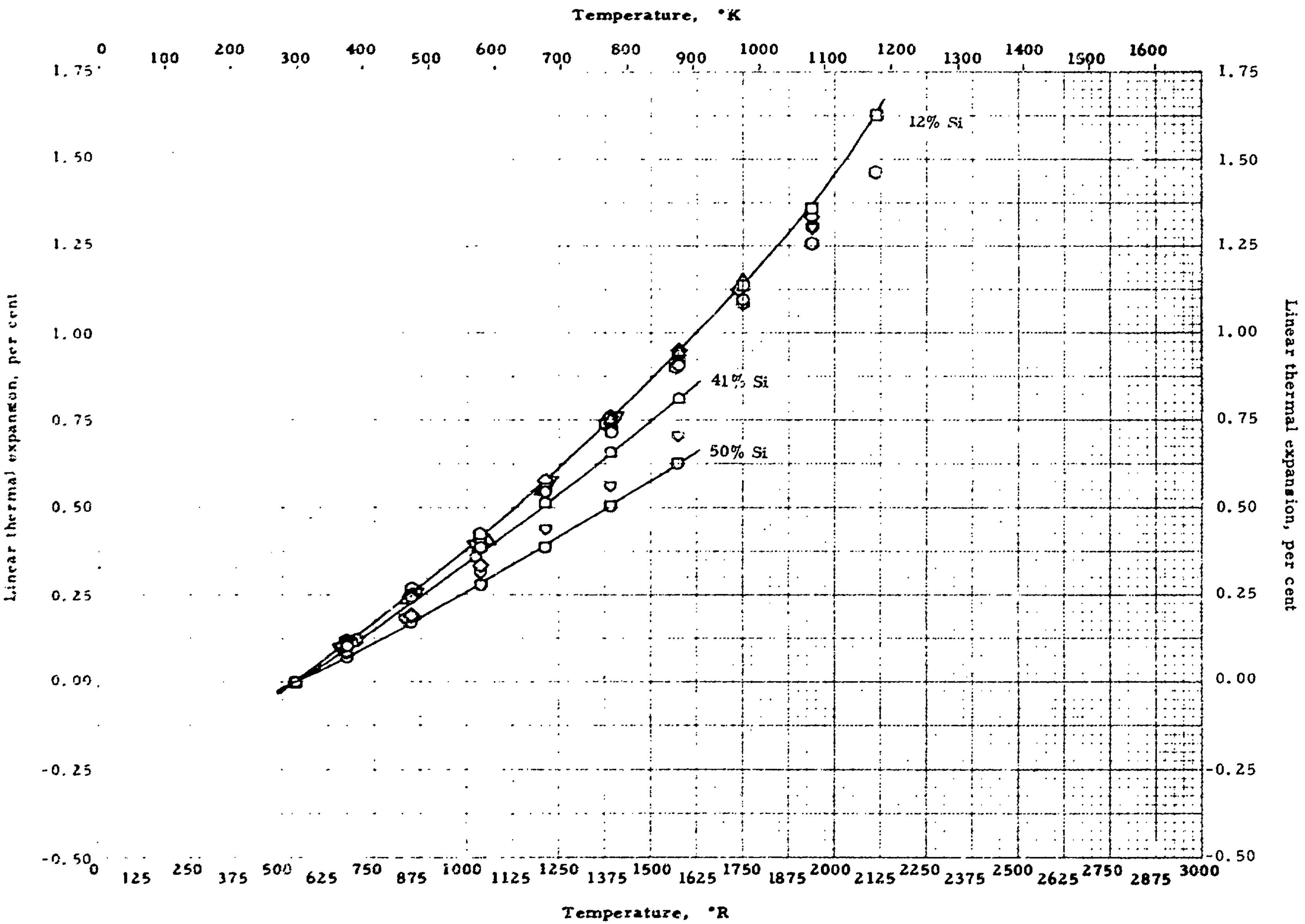


LINEAR THERMAL EXPANSION -- IRON + PLATINIUM

LINEAR THERMAL EXPANSION -- IRON + PLATINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kussman, A., and Rittberg, G. Grfn.	50-9	492-1392	55% Fe; 45% Pt: from Armco Iron and technically pure platinum induction melted in MgO crucible	Not given	Tempered

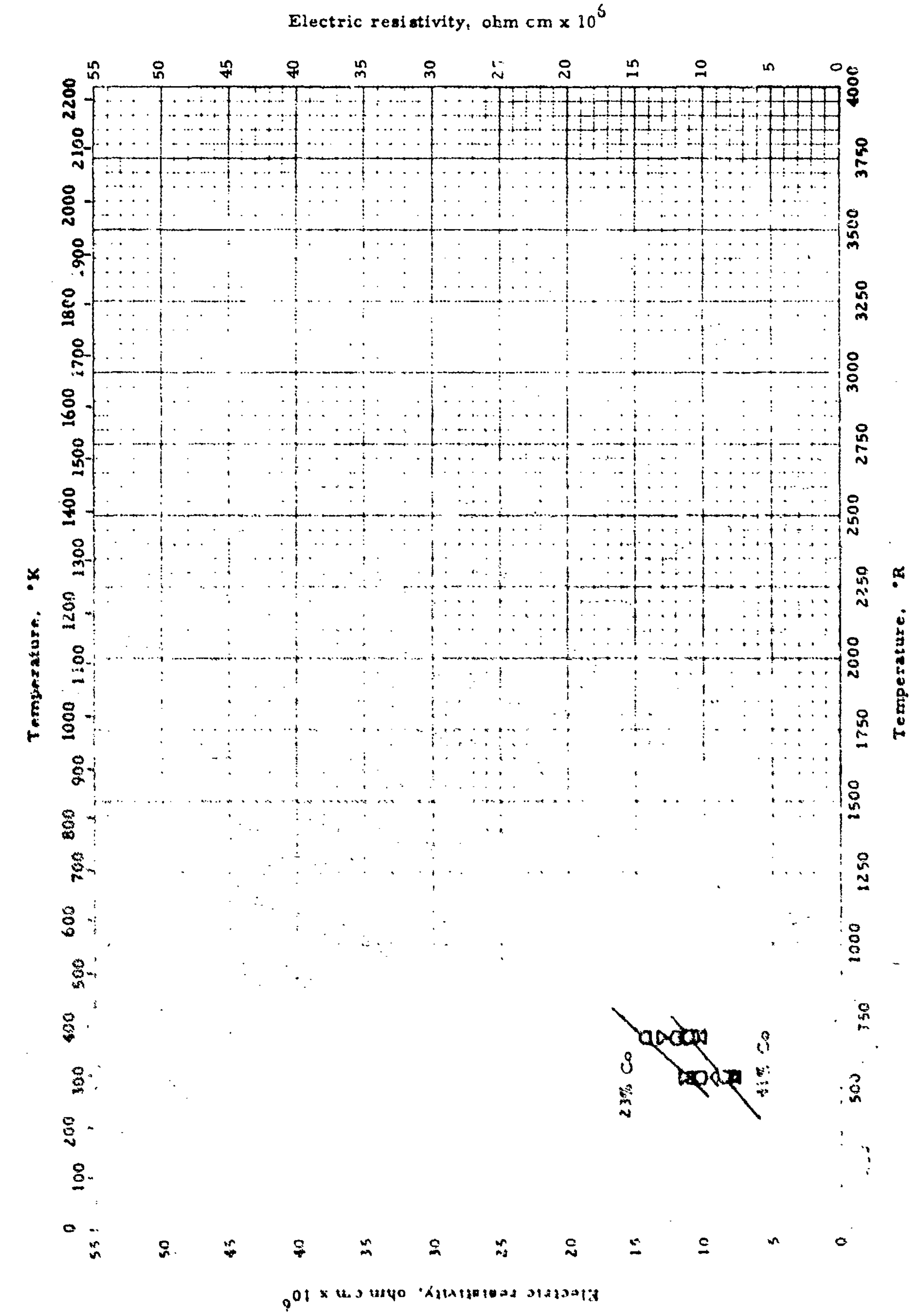


LINEAR THERMAL EXPANSION -- IRON + SILICON

LINEAR THERMAL EXPANSION -- IRON + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gel'd, V., Sebrennikov, N. N., and Sukharev, P. M.	56-39	672-1932	10.37% Si	Dilatometer	Annealed
□	Ibid.	56-39	672-2112	12.41% Si	Same as above	Same as above
△	Ibid.	56-39	672-1752	12.61% Si	Same as above	Same as above
◇	Ibid.	56-39	672-1932	20.01% Si	Same as above	Same as above
▽	Ibid.	56-39	672-1932	25.05% Si	Same as above	Same as above
○	Ibid.	56-39	672-2112	31.76% Si	Same as above	Same as above
⌂	Ibid.	56-39	672-1572	41.00% Si	Same as above	Same as above
♡	Ibid.	56-39	672-1572	45.20% Si	Same as above	Same as above
⬭	Ibid.	56-39	672-1572	50.20% Si	Same as above	Same as above

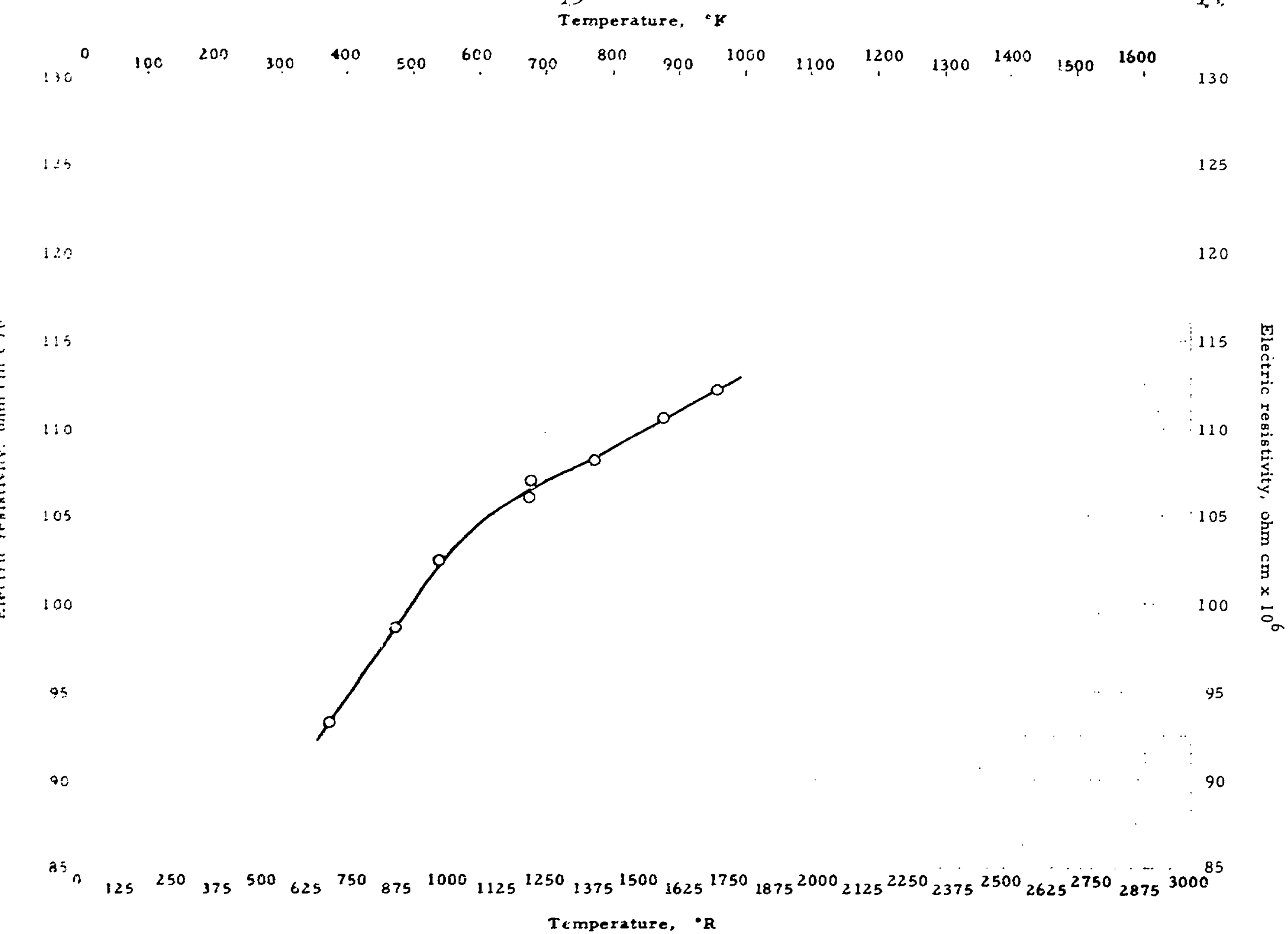


ELECTRIC RESISTIVITY -- IRON + COBALT

ELECTRIC RESISTIVITY -- IRON + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Viting, L. M.	57-66	537-672	59.44% Fe; 40.56% Co; prepared from electrolytic Co and "Armco" iron (0.02% C)	Potential drop	Annealed 1500 hr. at 500°C
□	Ibid.	57-66	537-672	60.91% Fe, 39.09% Co; raw material same as above	Same as above	Same as above
△	Ibid.	57-66	537-672	64.28% Fe; 35.72% Co; raw material same as above	Same as above	Same as above
◇	Ibid.	57-66	537-672	66.06% Fe; 33.94% Co; raw material same as above	Same as above	Same as above
▽	Ibid.	57-66	537-672	68.86% Fe; 31.14% Co; raw material same as above	Same as above	Same as above
○	Ibid.	57-66	537-672	71.01% Fe; 28.99% Co; raw material same as above	Same as above	Same as above
◻	Ibid.	57-66	537-672	76.55% Fe; 23.45% Co; raw material same as above	Same as above	Same as above

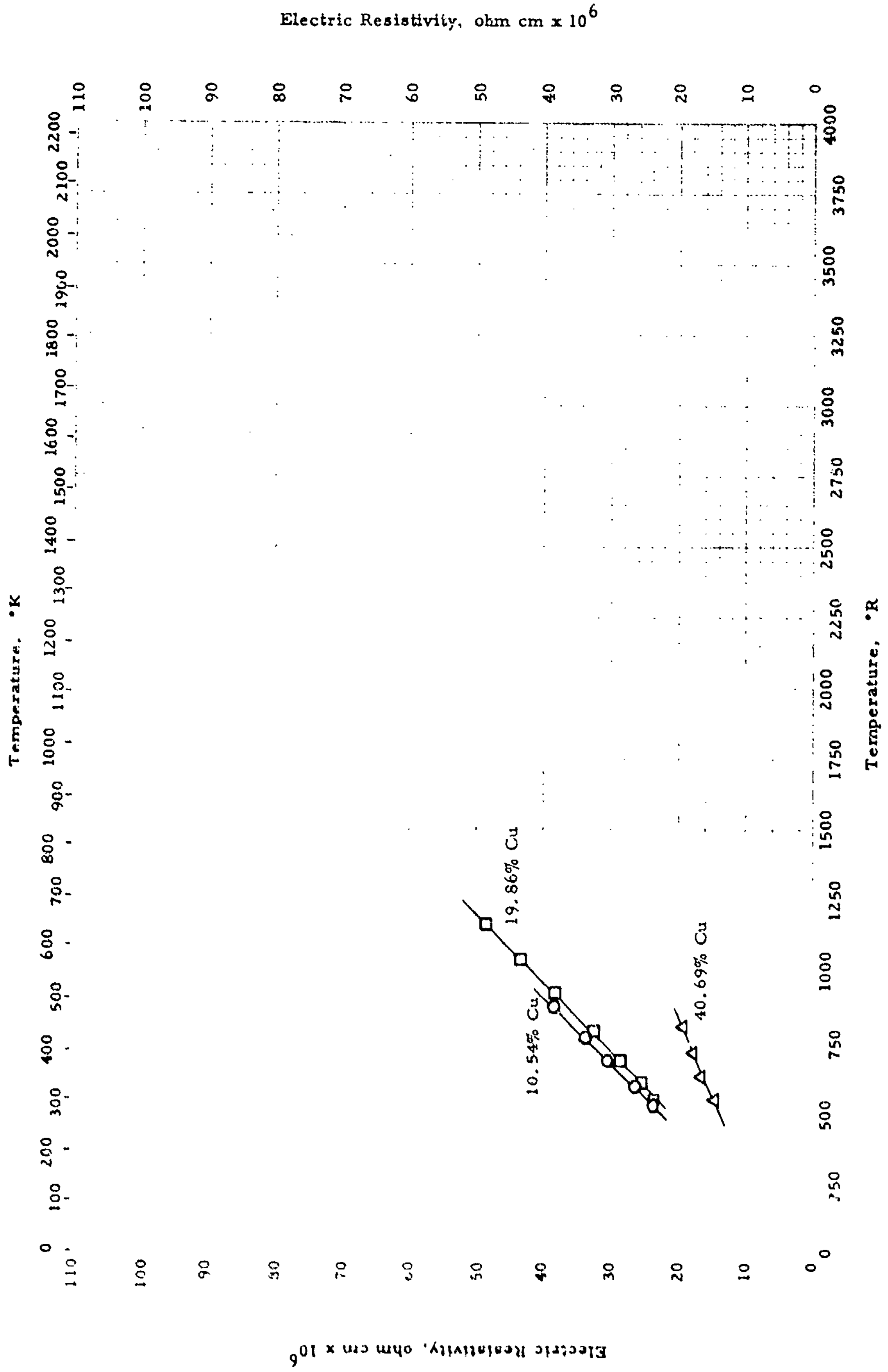


ELECTRIC RESISTIVITY -- IRON + COBALT + X

ELECTRIC RESISTIVITY -- IRON + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Perova, V. I. and Knorez, L. I.	57-117	671-1718	20% Co; 20% Cr; 20% Ni	Potential drop. Sample temp. by Chromel-Alumel thermocouple	Forged, quenched in oil from 1200°C, aged 70 hr. at 760°C. Auth. est. accuracy ± 1%

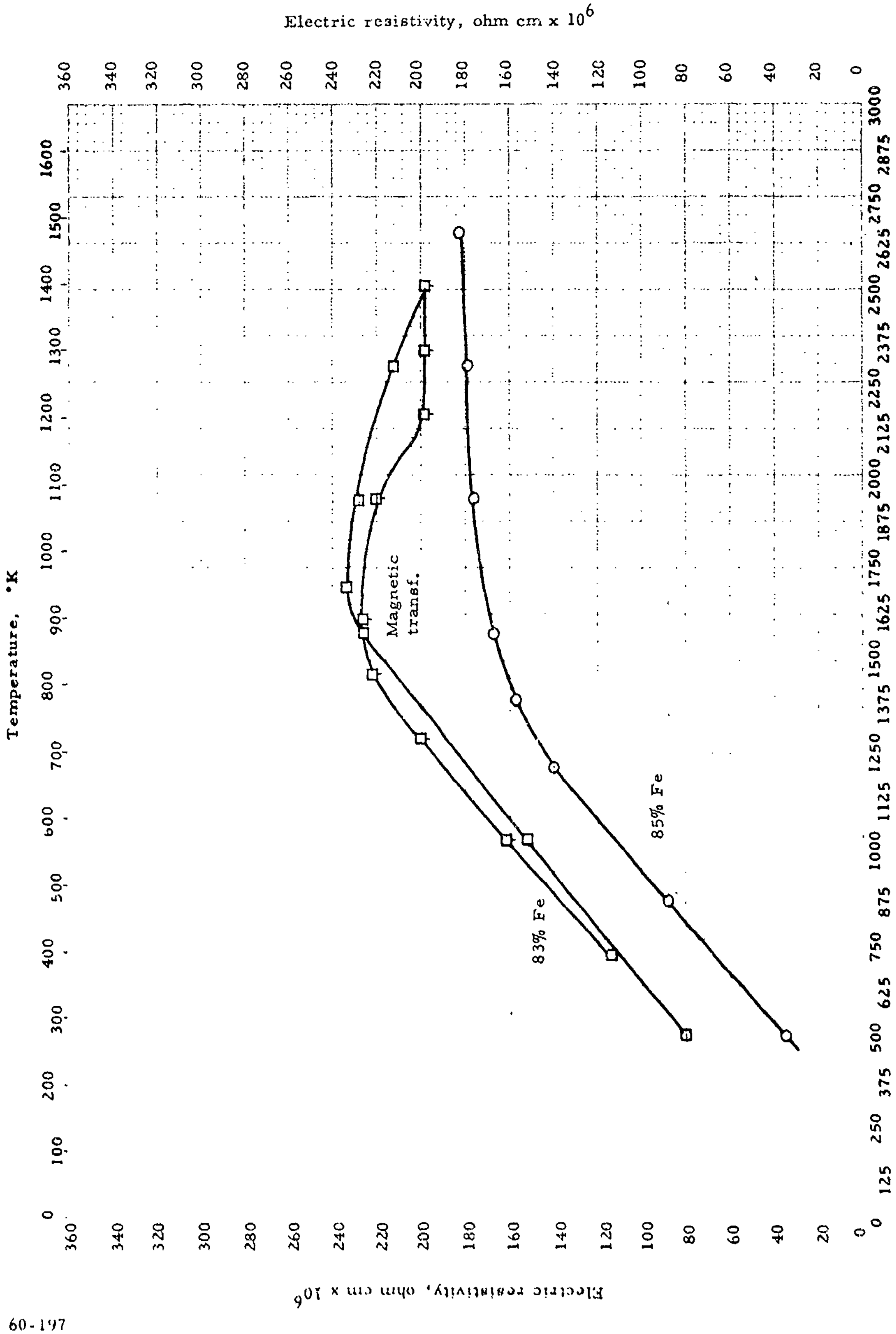


ELECTRIC RESISTIVITY -- POROUS IRON + COPPER + GRAPHITE ANTIFRICTION ALLOYS

ELECTRIC RESISTIVITY -- POROUS IRON + COPPER + GRAPHITE ANTIFRICTION ALLOYS

REFERENCE INFORMATION

Sym bol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E., and Pozdnyak, N. Z.	54-50	537-873	86.26% Fe; 10.54% Cu; 1.6% C; 0.42% Mn; 0.29% Si; porosity 10%; ρ = 465 lb_m/ft^3	Potential drop	Sintered 1.5 hr. at 1150°C in H_2 atmos.
□	Ibid.	54-50	546-1163	76.80% Fe; 19.86% Cu; 1.52% C; 0.39% Mn; 0.31% Si; porosity 10.5%; ρ = 479 lb_m/ft^3	Same as above	Same as above
△	Ibid.	54-50	546-807	56.15% Fe; 40.69% Cu; 1.5% C; 0.40% Mn; 0.29% Si; porosity 10.7%; ρ = 488 lb_m/ft^3	Same as above	Same as above

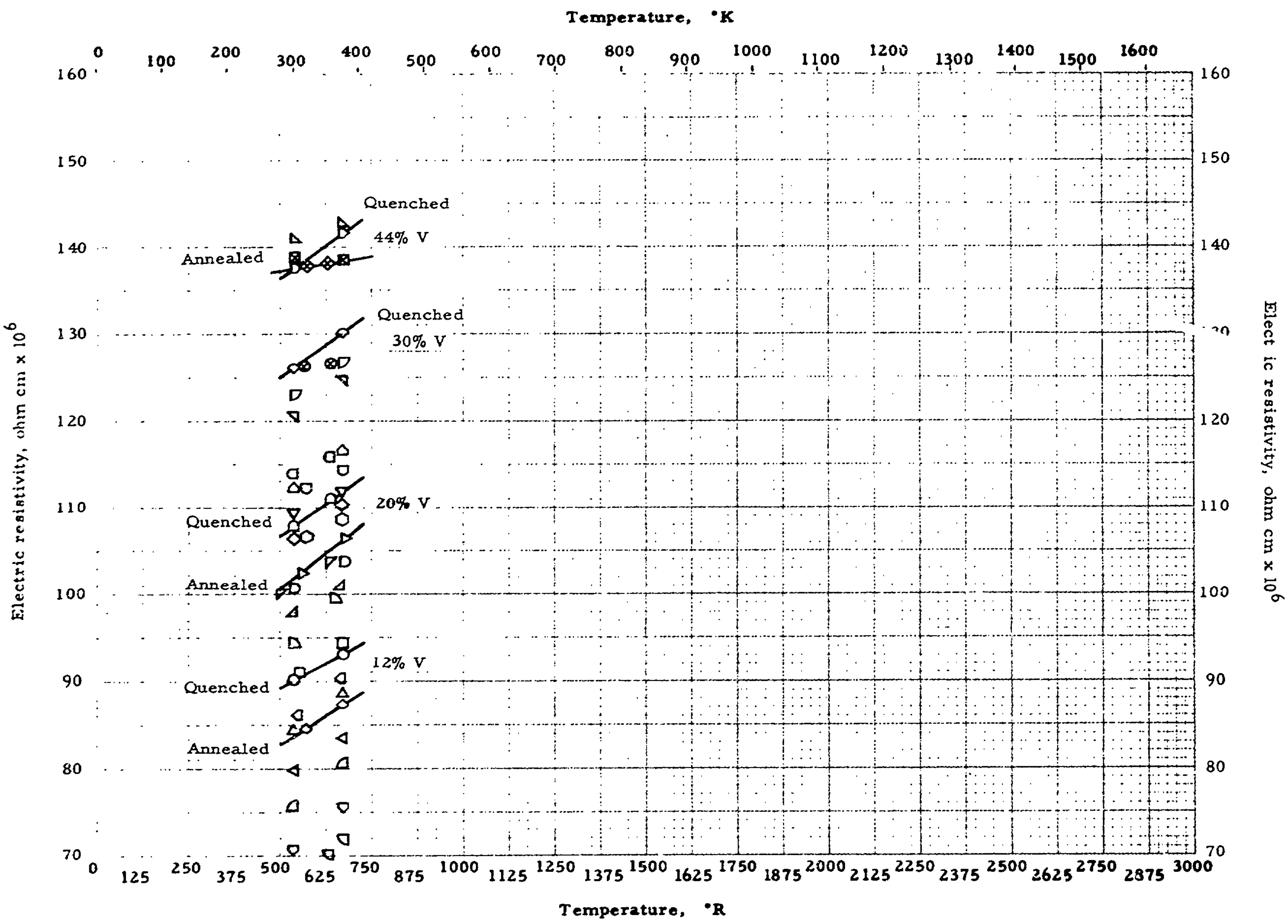


ELECTRIC RESISTIVITY -- IRON + SILICON

ELECTRIC RESISTIVITY -- IRON + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Glaser, F. W. and Ivanick, W.	56-122	492-2652	85% Fe; 15% Si	Not given	
□	Ibid.	56-122	492-2508	83.1% Fe; 16.9% Si	Not given	□ - heating □ - cooling



ELECTRIC RESISTIVITY -- IRON + VANADIUM
(10 - 50% V)

ELECTRIC RESISTIVITY -- IRON + VANADIUM
(10 - 50% V)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kornilov, I. I and Mikheev, V. S.	55-124	537-672	17.2% V	Not given	Annealed 20 hr. at 1220°C, soaked 2 hr. at 1300-1320°C, quenched in ice water
□	Ibid.	55-124	537-672	13.1% V	Same as above	Same as above
△	Ibid.	55-124	537-672	14.3% V	Same as above	Same as above
◇	Ibid.	55-124	537-672	16.9% V	Same as above	Same as above
▽	Ibid.	55-124	537-672	18.6% V	Same as above	Same as above
⬡	Ibid.	55-124	537-672	19.0% V	Same as above	Same as above
⌂	Ibid.	55-124	537-672	20.47% V	Same as above	Same as above
△	Ibid.	55-124	537-672	21.14% V	Same as above	Same as above
▢	Ibid.	55-124	537-672	21.8% V	Same as above	Same as above
▽	Ibid.	55-124	537-672	23.3% V	Same as above	Same as above
◺	Ibid.	55-124	537-672	27.2% V	Same as above	Same as above
◇	Ibid.	55-124	537-672	30.4% V	Same as above	Same as above
▱	Ibid.	55-124	537-672	38.80% V	Same as above	Same as above
▷	Ibid.	55-124	537-672	43.64% V	Same as above	Same as above
◇	Ibid.	55-124	537-672	12.2% V	Same as above	Annealed 70 hr. at 900°C, air cooled
◁	Ibid.	55-124	537-672	13.1% V	Same as above	Same as above
▢	Ibid.	55-124	537-672	16.9% V	Same as above	Same as above
▢	Ibid.	55-124	537-672	18.6% V	Same as above	Same as above
◿	Ibid.	55-124	537-672	19.0% V	Same as above	Same as above
◁	Ibid.	55-124	537-672	19.8% V	Same as above	Same as above
▷	Ibid.	55-124	537-672	20.5% V	Same as above	Same as above
◿	Ibid.	55-124	537-672	21.1% V	Same as above	Same as above
▢	Ibid.	55-124	537-672	21.8% V	Same as above	Same as above
▽	Ibid.	55-124	537-672	23.3% V	Same as above	Same as above
◁	Ibid.	55-124	537-672	27.2% V	Same as above	Same as above
▱	Ibid.	55-124	537-672	30.4% V	Same as above	Same as above
⊘	Ibid.	55-124	537-672	35.2% V	Same as above	Same as above

ELECTRIC RESISTIVITY -- IRON + VANADIUM (Cont'd)
(10 - 50% V)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
⊠	Kornilov, I. I. and Mikheev, V. S.	55-124	537-672	38.80% V	Not given	Annealed 70 hr. at 900 °C, air cooled
◈	Ibid.	55-124	537-672	43.64% V	Same as above	Same as above

PROPERTIES OF COPPER + ZINC + LEAD + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 36% Zn	528 lb_m/ft^3	8.46 g/cm^3
Melting Point 36% Zn .	2110°R *	1175°K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11).

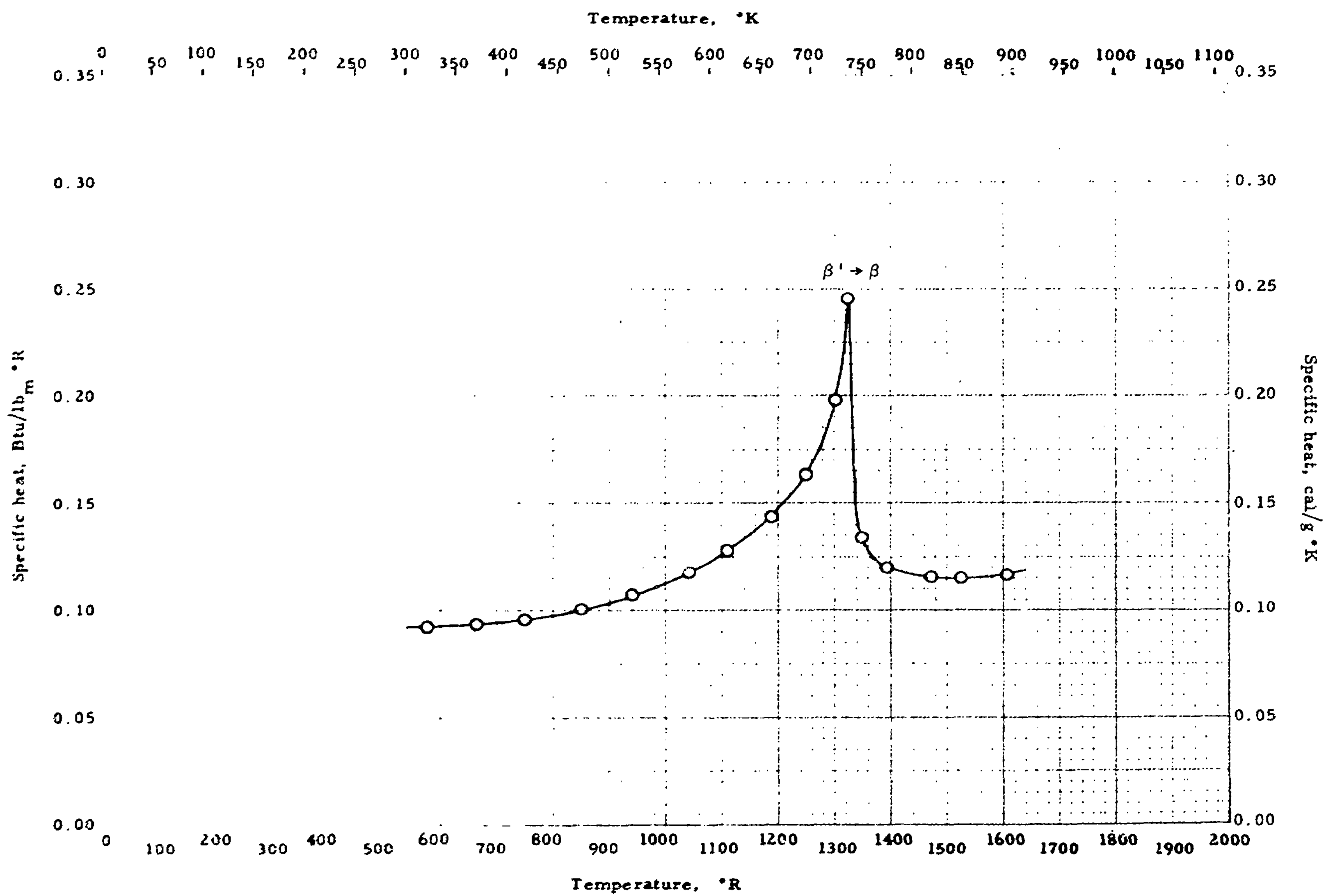
REPORTED VALUES

Density:	lb_m/ft^3	g/cm^3
	528	8.46
Melting Point:	°R	°K
Heat of Fusion:	Btu/lb_m	cal/g
Heat of Vaporization:	Btu/lb_m	cal/g
Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF COPPER + ZINC + LEAD + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L., Roder, H. M. and Rogers, W. M.	57-37	Room	Free cutting leaded brass 35.7% Zn; 3.27% Pb; 1% Sn; 0.01% ea. Bi, Cd, Fe, Ni, Ag	ρ: not given	

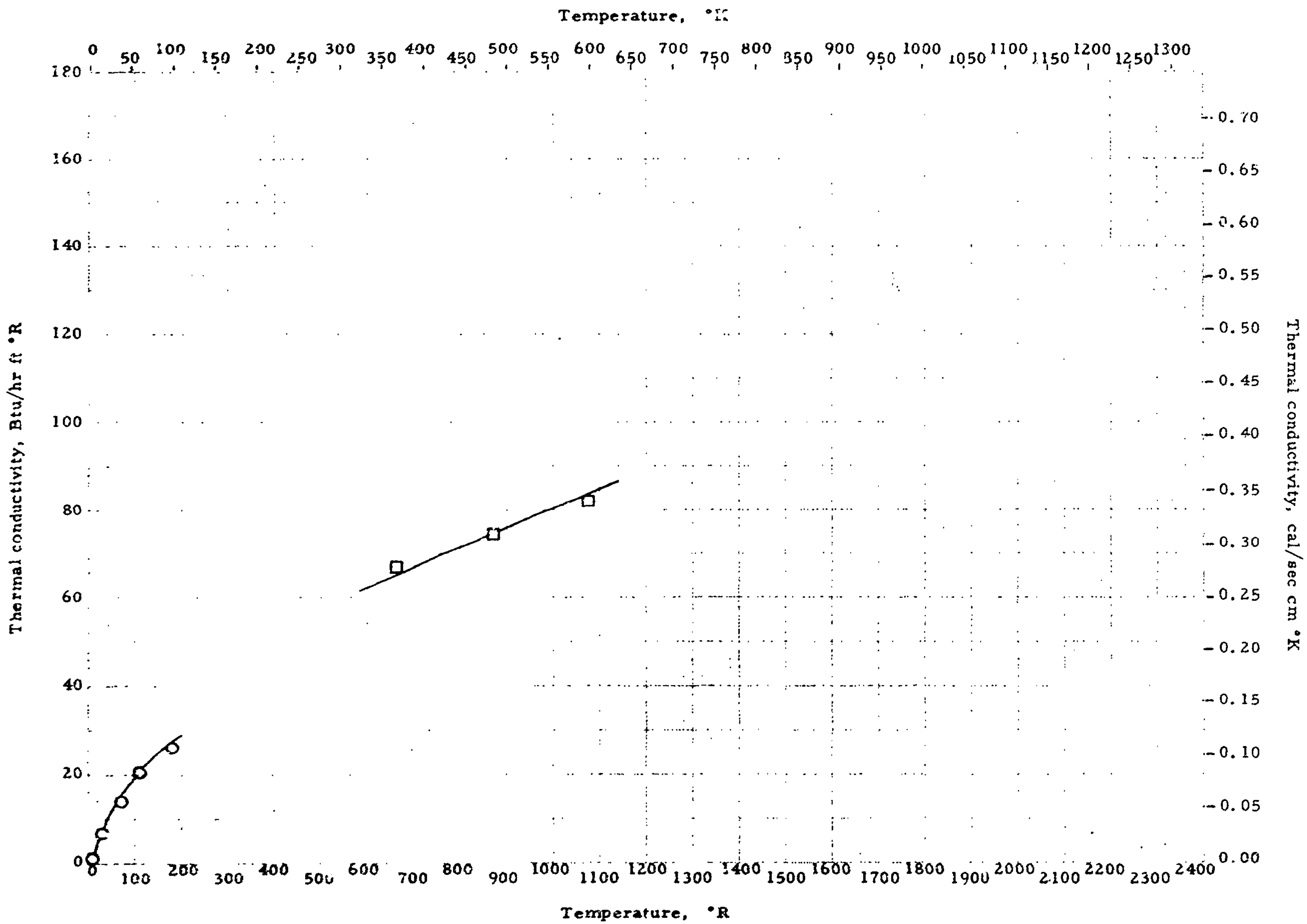


SPECIFIC HEAT -- COPPER + ZINC + LEAD

SPECIFIC HEAT -- COPPER + ZINC + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Moser, H.	41-13	580-1608	Brass, β-phase; 51.8% Cu; 48.17% Zn; 0.03% Pb; traces of Fe	Guarded sample	In A atmos. at reduced press.

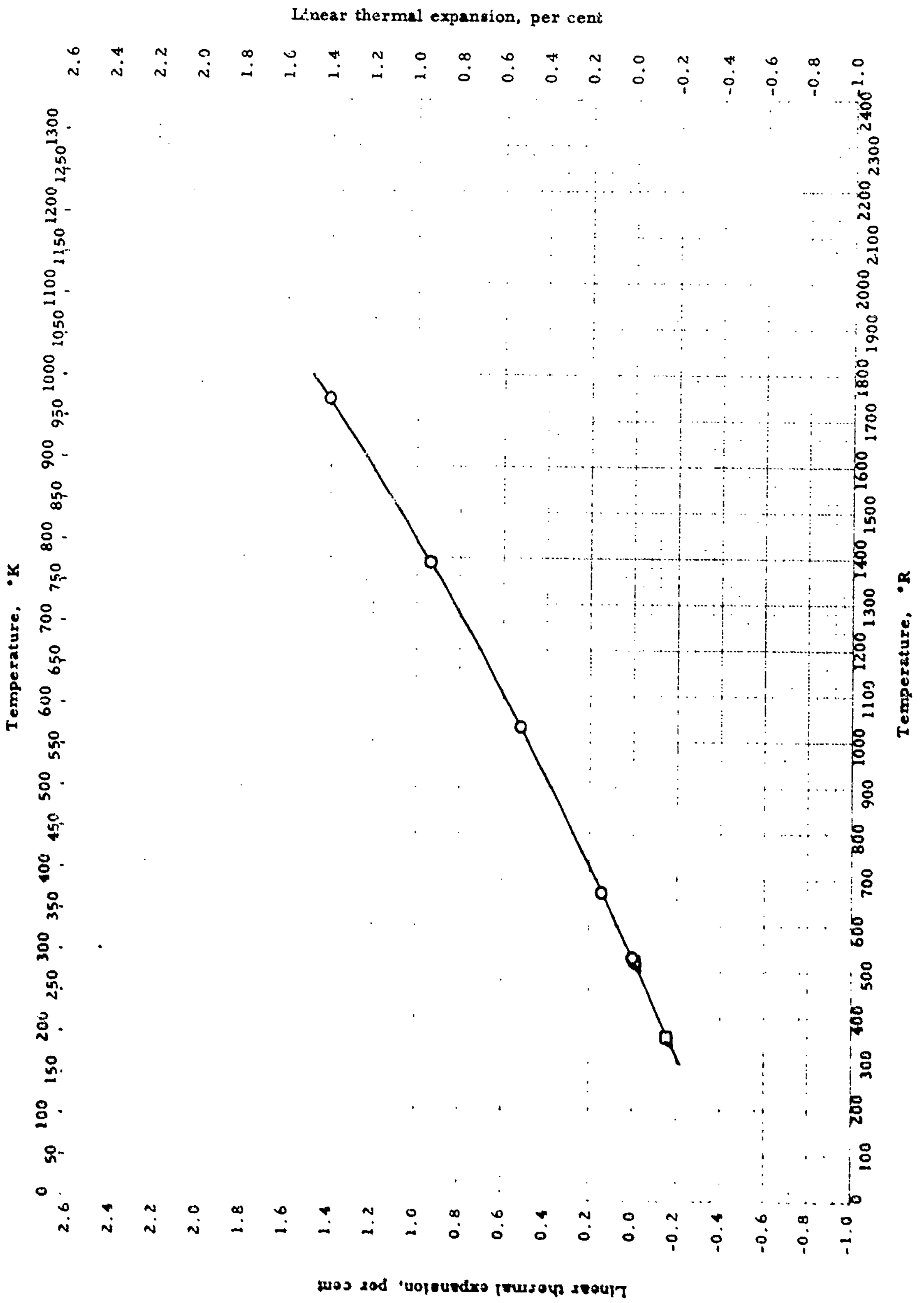


THERMAL CONDUCTIVITY -- COPPER + ZINC + LEAD + X

THERMAL CONDUCTIVITY -- COPPER + ZINC + LEAD + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L., Roder, H. M., and Rogers, W. M.	[illegible]	7-180	Free cutting leaded brass: 35.7% Zn, 3.27% Pb; 1% Sn; 0.01% ea. Bi, Cd, Fe, Ni, Ag; ρ = 528 lb_m/ft^3	Axial heat flow in rod; guarded heat source and sample	Tested in vacuum, $< 10^{-6}$ mm Hg
□	[illegible], Jr., [illegible]	[illegible]	660-1068	Brass: 35.5% Zn; 3% Pb	Comparative; rods	Auth. est. accuracy ± 4%

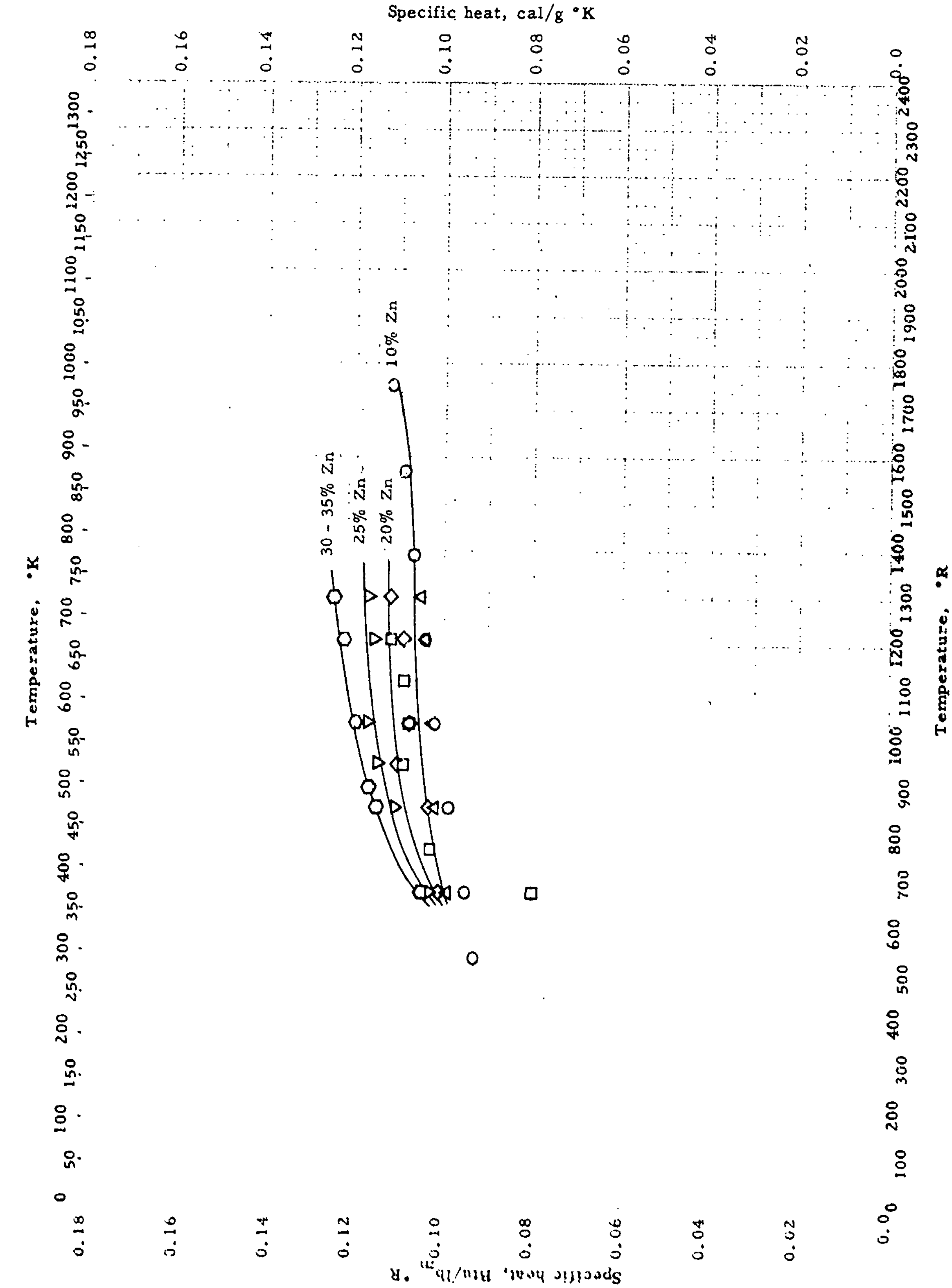


LINEAR THERMAL EXPANSION -- COPPER + ZINC + TIN + X

LINEAR THERMAL EXPANSION -- COPPER + ZINC + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P., and Dickson, G.	43-6	528-1752	Red Brass: 84.96% Cu; 5.15% Zn; 5.02% Sn; 4.87% Pb	Telemicroscopes sighting on wires supporting sample	Cast rod
□	Perry, Stanley	45-6	360-528	Manganese Bronze No. 937: 59.0% Cu; 39.0% Zn; 0.70% Sn; 0.50% Mn; 0.08% Fe	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
△	Ibid.	45-6	360-528	Naval Brass No. 452: 60.0% Cu; 39.25% Zn; 0.75% Sn	Same as above	Same as above

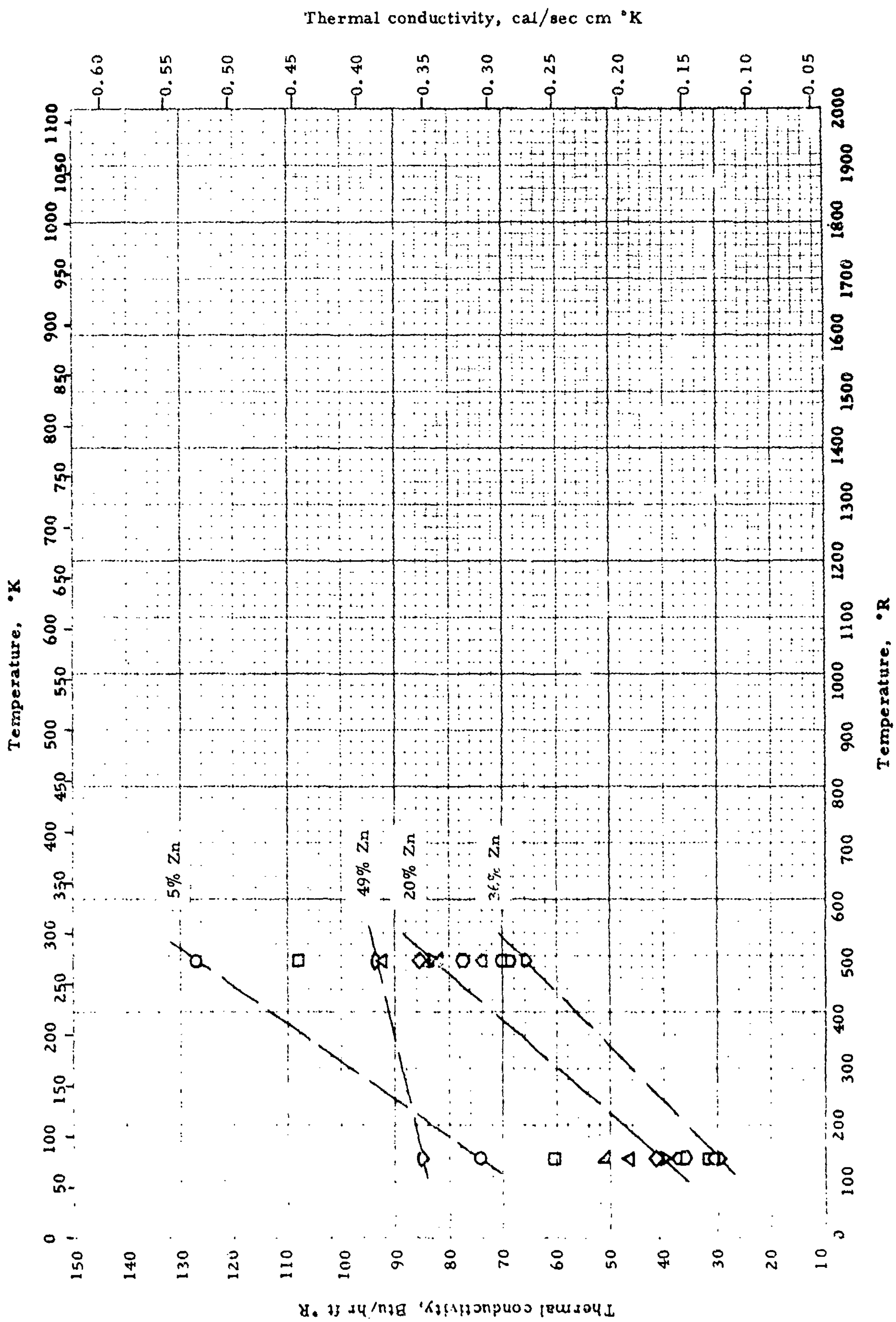


SPECIFIC HEAT -- COPPER + ZINC

SPECIFIC HEAT -- COPPER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Forsler, F., and Tschentke, G.	40-6	528-1752	Brass. 10-30% Zn	Slope of initial temp. rise curve in resistance heated sample	Tempered several hr. at 500°C; tested in N_2 atmos. Plotted points show avg (within 2%) for 3 samples containing 10, 20, and 30% Zn
□	Hirano, K., Maniwa, H., and Tagaki, Y.	55-29	672-1212	70% Cu; 30% Zn	Not given; probably direct method	Sample 1: quenched from 800°C; annealed 2000 hr. at 130°C. Sample 2: cooled from 600°C at 3°C per min. Plotted points show avg. data (within 4%)
△	Masumoto, H., Saito, H., and Sugihara, M.	52-77	672-1302	4.56-16.00% Zn	Comparative; rate of temp. drop in sample compared with Cu standard under same cooling conditions	Annealed 1 hr. at 700°C; slowly cooled. Plotted points show avg. (within 2%) for 3 samples containing 4.56, 12.25, and 16.00% Zn
◇	Ibid.	52-77	672-1302	20.75% Zn	Same as above	Annealed 1 hr. at 700°C, slowly cooled
▽	Ibid.	52-77	672-1302	25.75% Zn	Same as above	Treatment 1: annealed 1 hr. at 700°C, slowly colled. Treatment 2: heated to 700°C, held 30 min., furnace cooled to 500°C, held 10 min., and water quenched. Plotted points show avg. with max. deviation of 5% (at 200°C)
○	Ibid.	52-77	672-1302	30.35-36.87% Zn	Same as above	Samples with 30.35% Zn given both treatments as above. Sample with 36.87% Zn given treatment 1 only. Plotted points show avg. with max. deviation of 5% (at 200°C)

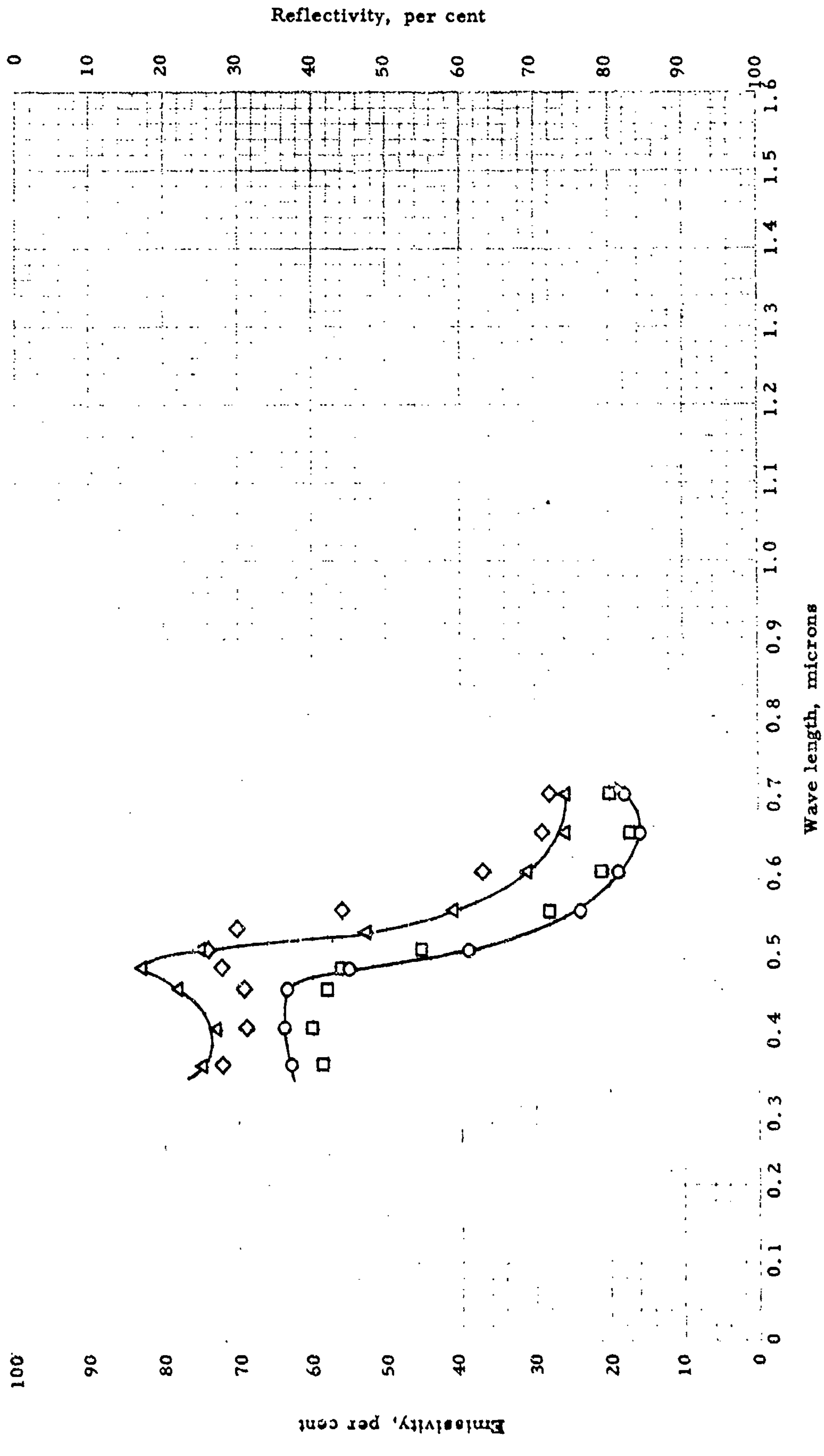


THERMAL CONDUCTIVITY -- COPPER + ZINC

THERMAL CONDUCTIVITY -- COPPER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Aoyama, S., and Ito, T.	40-11	141-492	4.54% Zn; prepared from electrolytic Cu containing 0.015% Sb; 0.010% Fe; 0.007% S; 0.0003% As	Comparative; rods	Melted, cast, high temperature forged. Annealed 20 hr. at 380-400°C in N_2 atmos.
□	Ibid.	40-11	141-492	7.18% Zn; raw material same as above	Same as above	Same as above
△	Ibid.	40-11	141-492	13.13% Zn; raw material same as above	Same as above	Same as above
◇	Ibid.	40-11	141-492	17.42% Zn; raw material same as above	Same as above	Same as above
▽	Ibid.	40-11	141-492	20.27% Zn; raw material same as above	Same as above	Same as above
○	Ibid.	40-11	141-492	24.56% Zn; raw material same as above	Same as above	Same as above
⌂	Ibid.	40-11	141-492	30.00% Zn; raw material same as above	Same as above	Same as above
▽	Ibid.	40-11	141-492	35.95% Zn; raw material same as above	Same as above	Same as above
▢	Ibid.	40-11	141-492	37.70% Zn; raw material same as above	Same as above	Same as above
△	Ibid.	40-11	141-492	40.07% Zn; raw material same as above	Same as above	Same as above
◭	Ibid.	40-11	141-492	44.38% Zn; raw material same as above	Same as above	Same as above
◇	Ibid.	40-11	141-492	48.91% Zn; raw material same as above	Same as above	Same as above

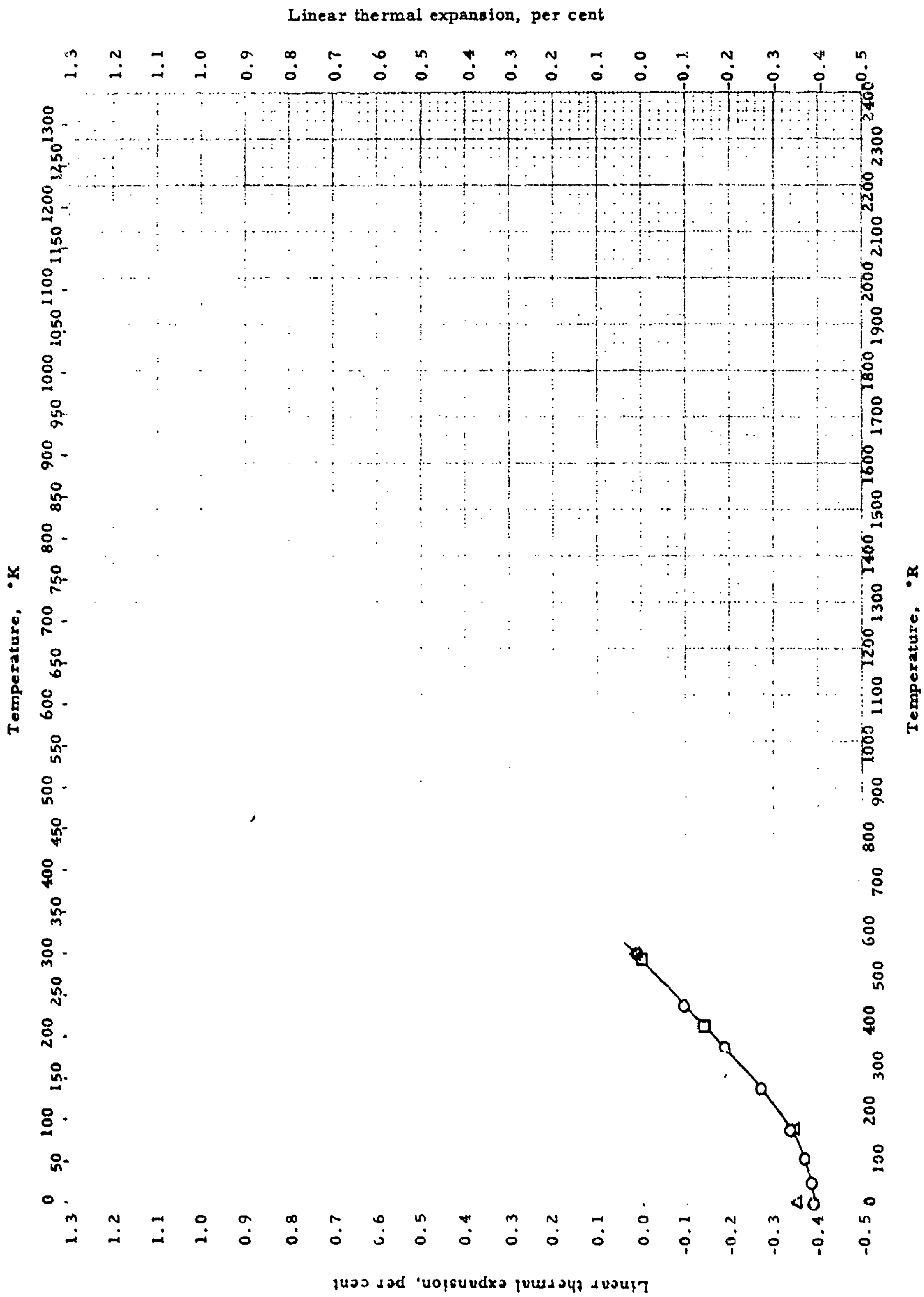


SPECTRAL EMISSIVITY -- COPPER + ZINC

SPECTRAL EMISSIVITY -- COPPER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Muldawer, L.	57-96	541	α - brass; 20% Zn	Spectral reflectivity at 18°: Beckman spectrophotometer; temp. by Fe Const. thermocouple: N_2 atmos.	Polished surface: N_2 atmos.
□	Ibid.	57-96	976	Same as above	Same as above	Same as above
△	Ibid.	57-96	541	β - brass	Same as above	Same as above
◇	Ibid.	57-96	987	Same as above	Same as above	Same as above

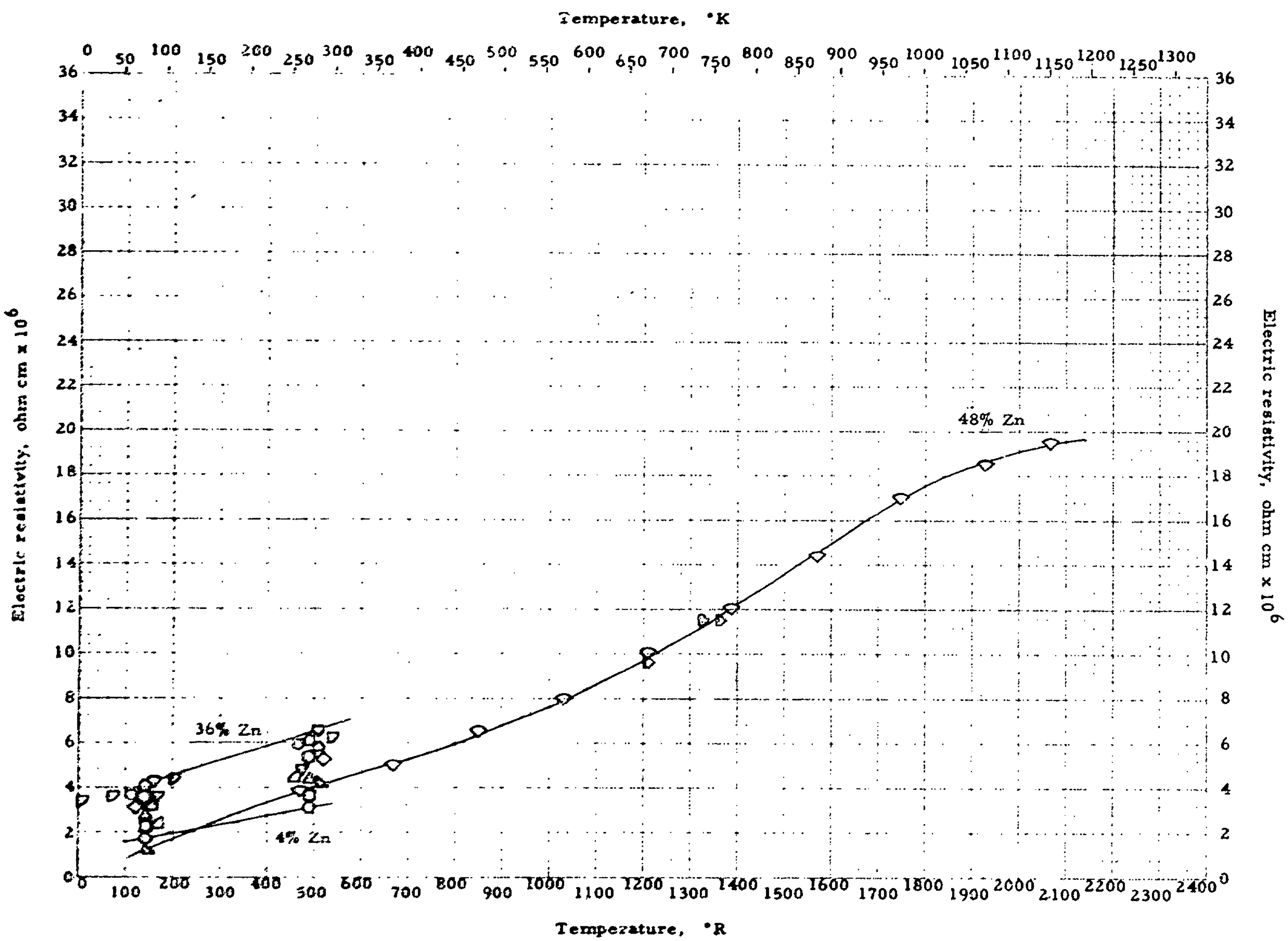


LINEAR THERMAL EXPANSION -- COPPER + ZINC

LINEAR THERMAL EXPANSION -- COPPER + ZINC

REFERENCE INFORMATION

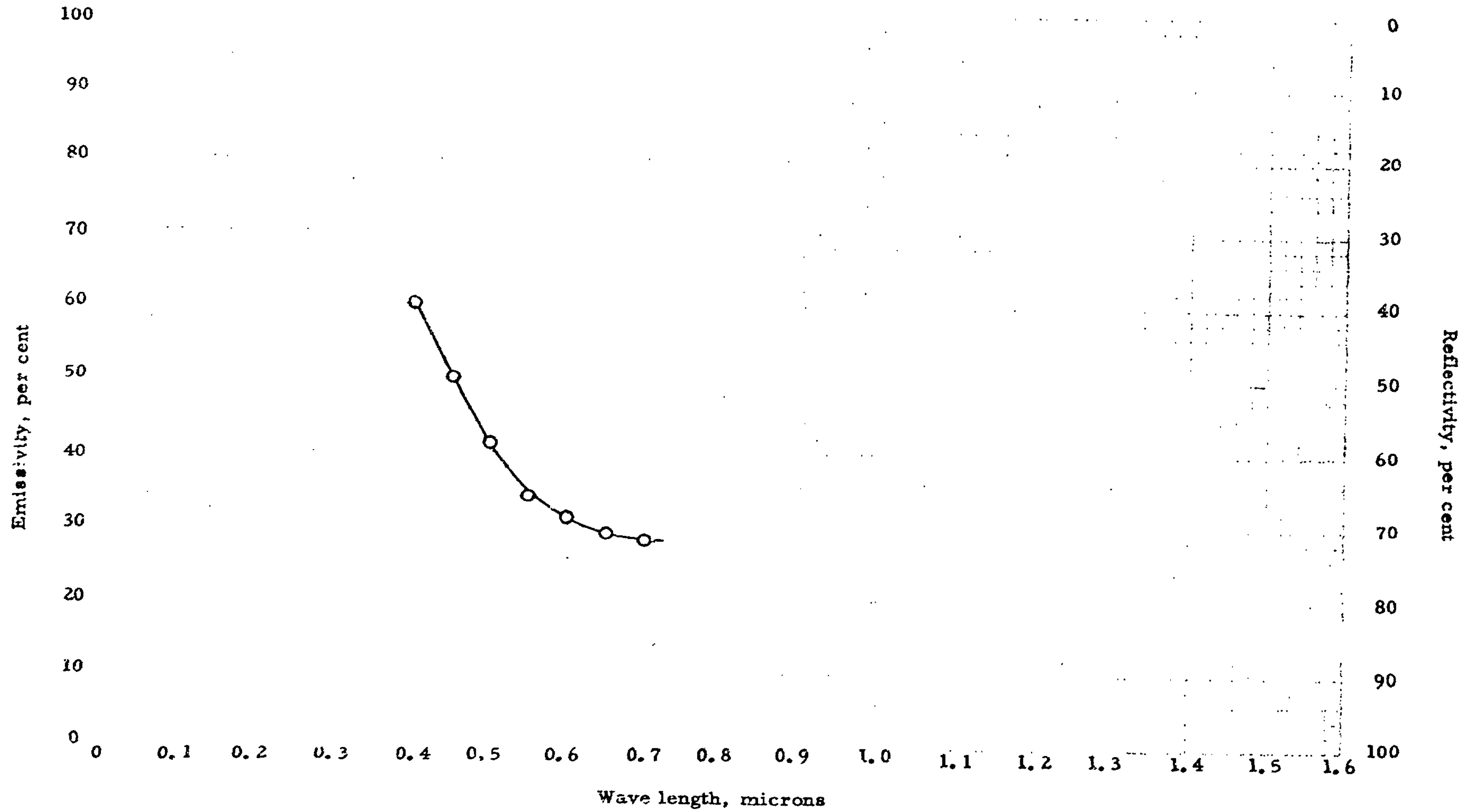
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Altman, H. W., Rubin, T. and Johnston, H. L.	54-39	0-540	Yellow brass; 65% Cu; 35% Zn	Interferometer	
□	Perry, S.	45-6	360-528	94.88% Cu; 4.98% Zn; 0.14% impurities	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
△	Fraser, D. B. and Hallett, A. C. H.	55-28	7-540	"Brass"	Elongation meas. by separation of 2 absorption lines of Hg from diffraction grating ruled on sample. Temp. meas. by boiling points of cooling fluids	



ELECTRIC RESISTIVITY -- COPPER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Aoyama, S. and Ito, T.	40-11	141-492	4.54% Zn; raw Cu was electrolytic containing 0.015% Sb; 0.010% Fe; 0.007% S; 0.0003% As	Potential drop	
□	Ibid.	40-11	141-492	7.18% Zn; raw material same as above	Same as above	
△	Ibid.	40-11	141-492	13.13% Zn; raw material same as above	Same as above	
◇	Ibid.	40-11	141-492	17.42% Zn; raw material same as above	Same as above	
▽	Ibid.	40-11	141-492	20.27% Zn raw material same as above	Same as above	
○	Ibid.	40-11	141-492	24.56% Zn; raw material same as above	Same as above	
□	Ibid.	40-11	141-492	30.00% Zn; raw material same as above	Same as above	
◇	Ibid.	40-11	141-492	35.95% Zn; raw material same as above	Same as above	
□	Ibid.	40-11	141-492	37.70% Zn; raw material same as above	Same as above	
△	Ibid.	40-11	141-492	40.07% Zn; raw material same as above	Same as above	
◁	Ibid.	40-11	141-492	44.38% Zn; raw material same as above	Same as above	
◣	Ibid.	40-11	141-492	48.91% Zn; raw material same as above	Same as above	
◇	Pecijare, O. and Janssen, S.	57-99	492-2040	48% Zn	Not given	
▽	Friedberg, S.A.	46-12	7-538	α Brass: 70% Cu; 30% Zn	Not described here, refers to others	Drawn wire, annealed 3 hr. at 592° K
▷	Rhines, F.N. and Newkirk, J.B.	52-120	1207-1356	β Brass: 52.21% Cu; 47.79% Zn	Potential drop in A atmosphere	Sample held 24 hr. at each temperature before each measurement

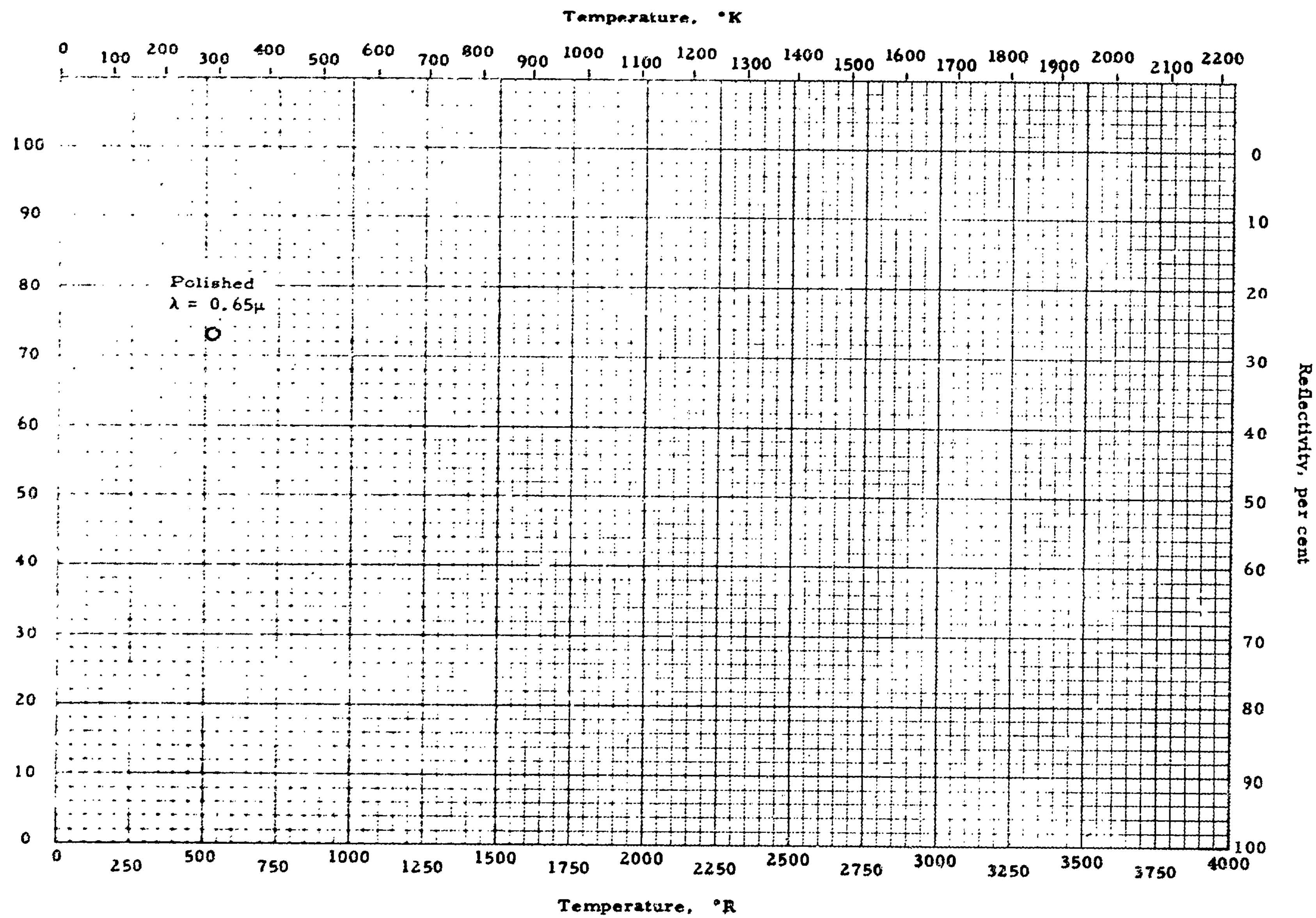


SPECTRAL EMISSIVITY -- COPPER + ZINC + NICKEL

SPECTRAL EMISSIVITY -- COPPER + ZINC + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bloom, F. K.	53-88	Room	Nickel silver; nominal: 55% Cu; 25% Zn; 20% Ni	Spectral reflectivity: Harding spectrophotometer	Polished metallographically

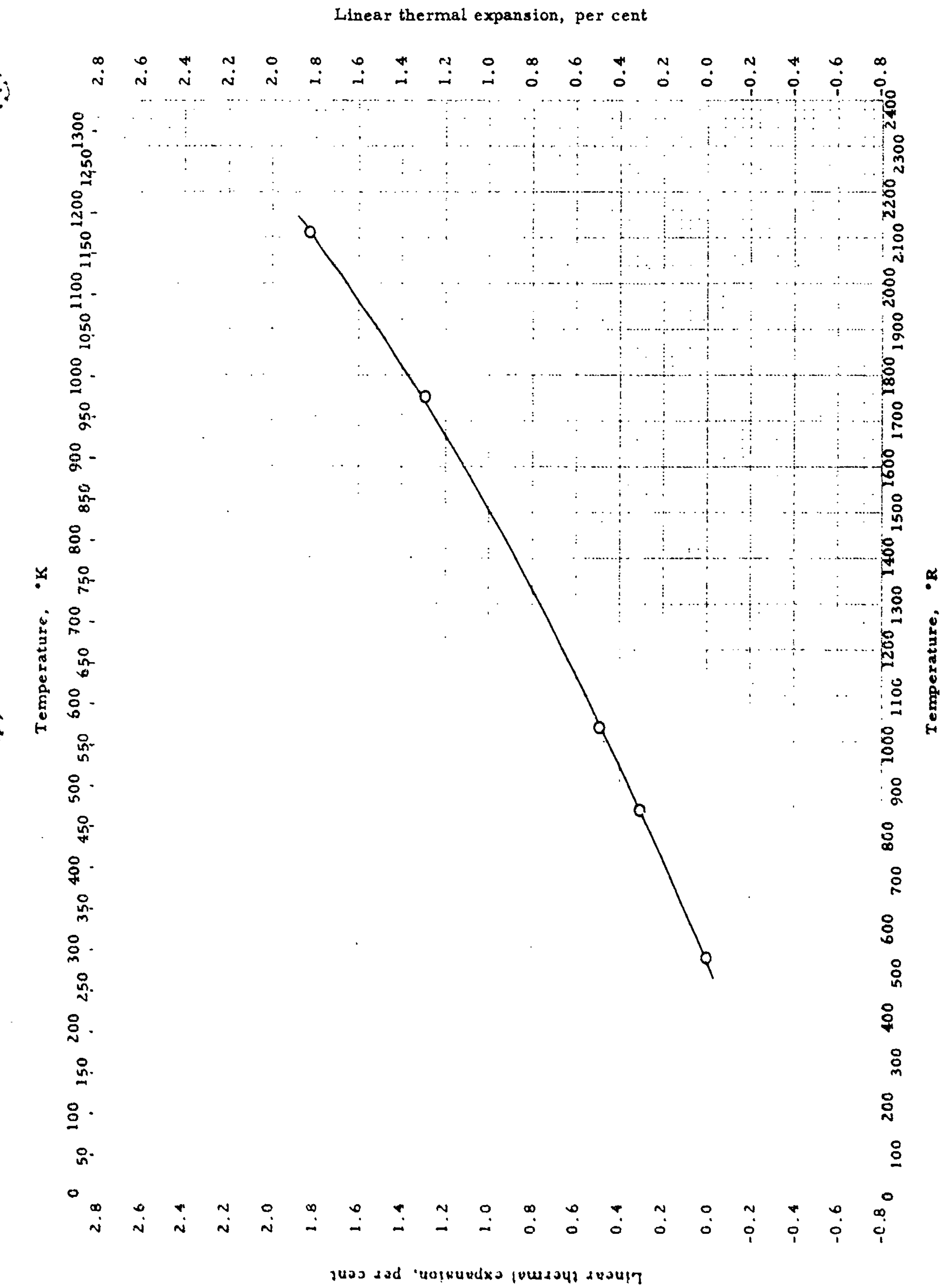


EMISSIVITY -- COPPER + ZINC + NICKEL

EMISSIVITY -- COPPER + ZINC + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bloom, F.K.	53-88	Room	Nickel Silver: 55% Cu; 25% Zn; 20% Ni	Spectral reflectivity of 0.650μ: Harding recording spectrophotometer	Polished metallographically

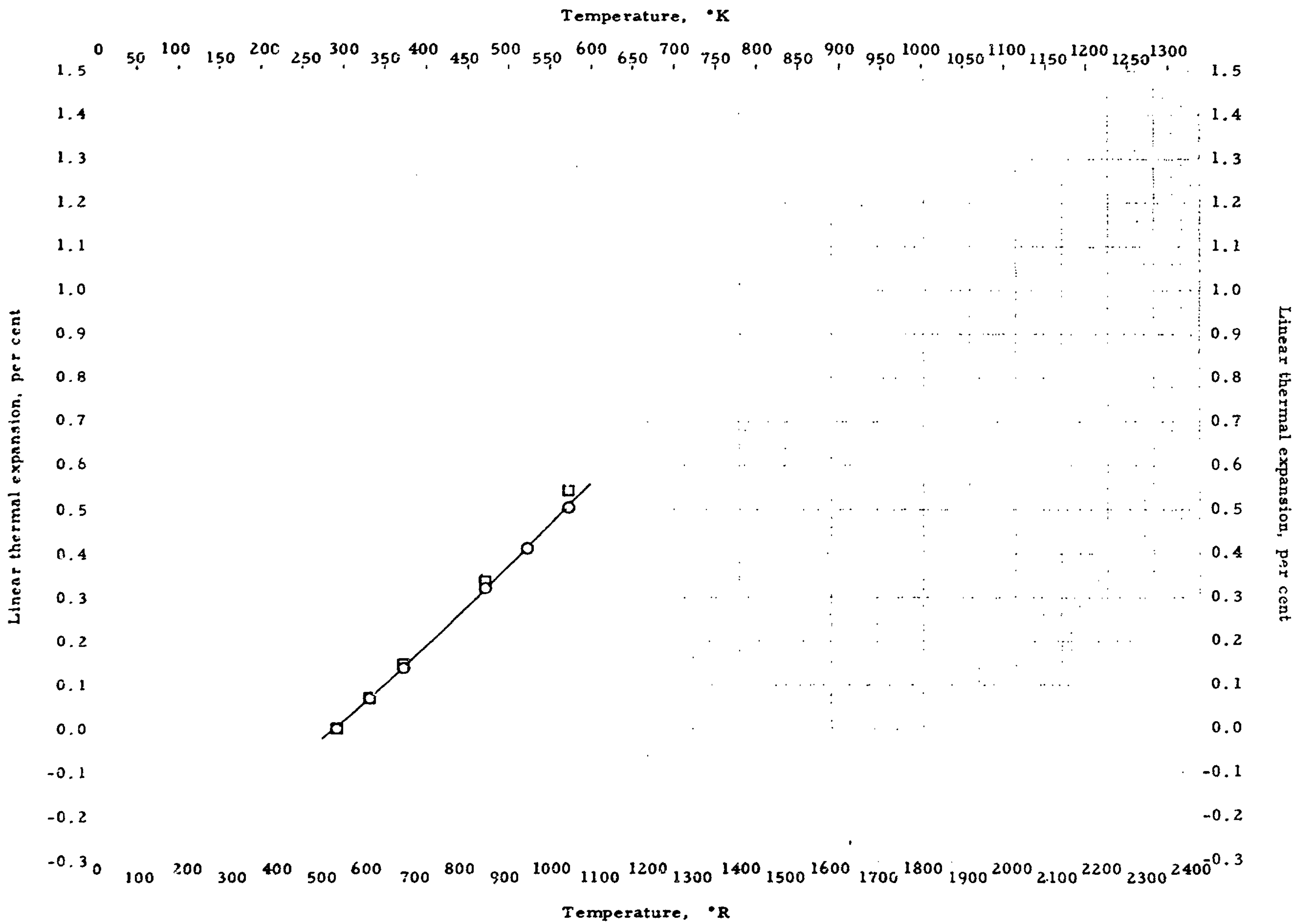


LINEAR THERMAL EXPANSION -- COPPER + ZINC + NICKEL + X

LINEAR THERMAL EXPANSION -- COPPER + ZINC + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hidnert, P., and Dickson, G.	43-6	528-2112	Wrought Aterite: 65% Cu; 22% Zn; 11% Ni; 1.5% Fe; 0.5% Mn	Telemicroscopes sighting on wires supporting sample	Cold drawn

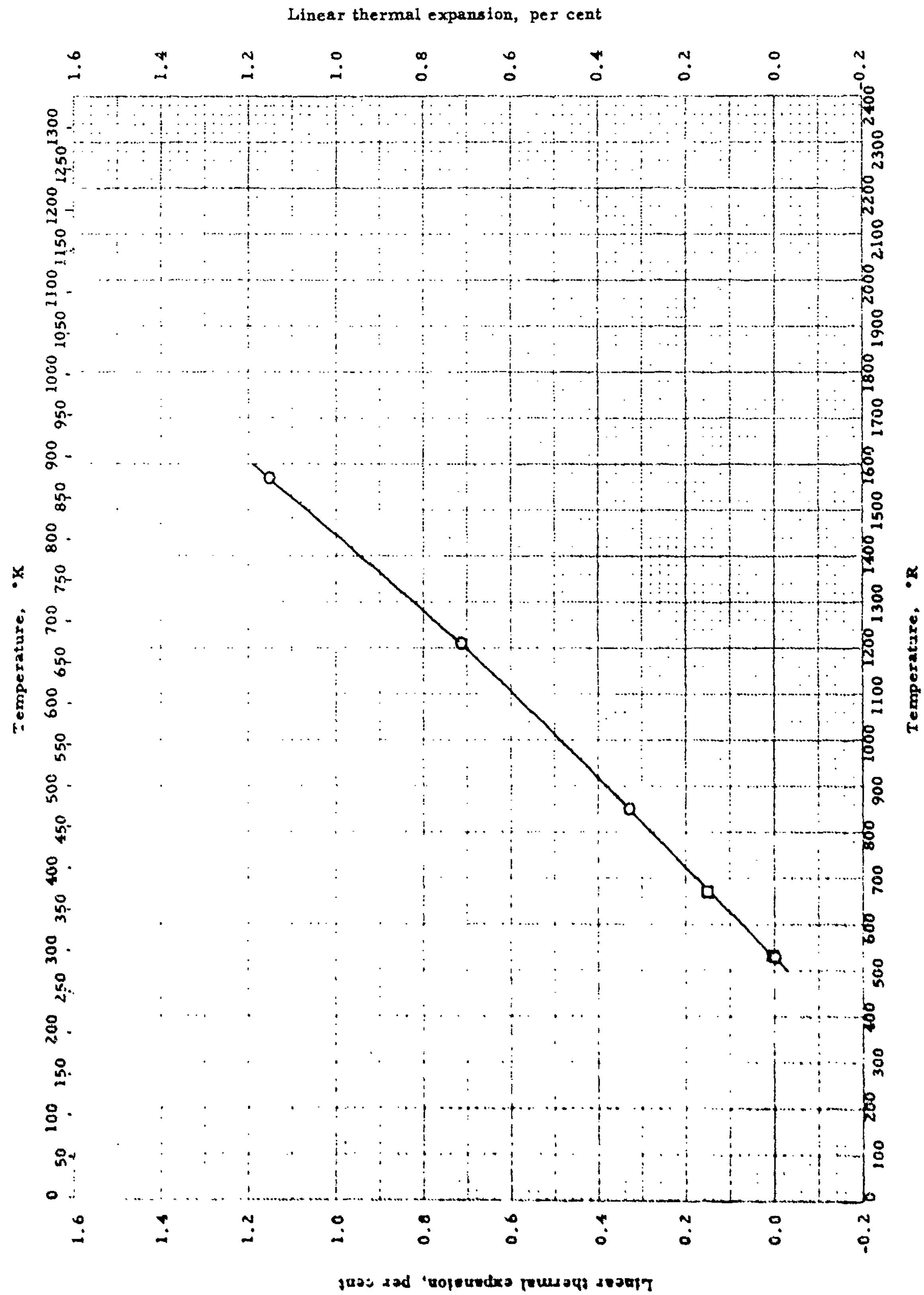


LINEAR THERMAL EXPANSION -- COPPER + ZINC + X

LINEAR THERMAL EXPANSION -- COPPER + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P., and Krider, H. S.	47-7	528-1032	Tellurium Nickel Brass: 88.84% Cu; 9.28% Zn; 1.15% Ni; 0.52% Te; 0.21% Pb	Telemicroscopes sighting on wires supporting sample	Plotted data show avg. (within 2%) for 4 samples: quenched from 1450°F, aged 1 hr. at 770 to 850°F and 18 to 40 months at room temp. Two of above cold drawn 34% after quenching
□	Ibid	47-7	528-1032	Aluminum Brass: 76.60% Cu; 21.47% Zn; 1.91% Al; < 0.05% Pb; 0.02% Fe	Same as above	Annealed at 1200°F

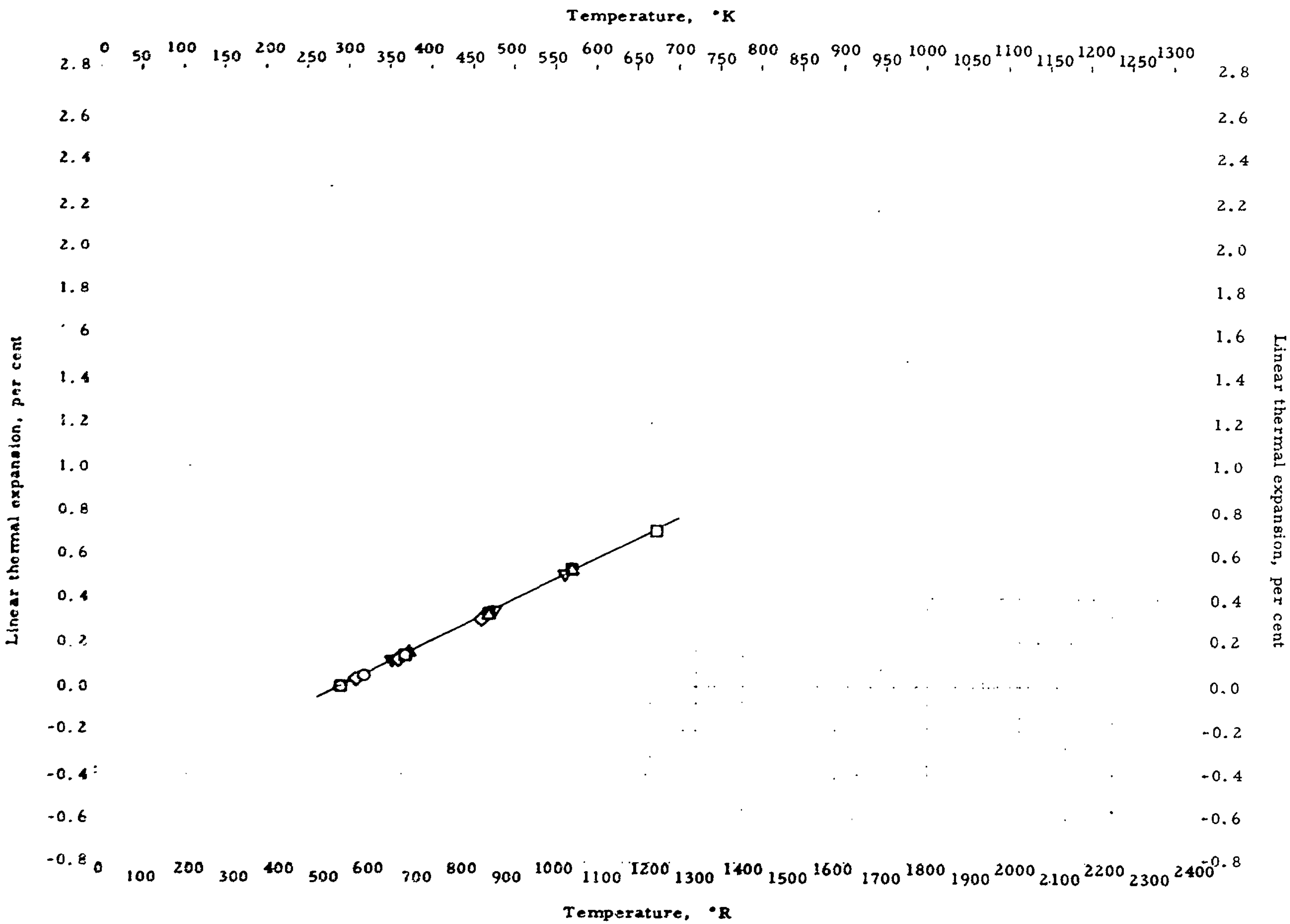


LINEAR THERMAL EXPANSION -- COPPER + TIN + LEAD

LINEAR THERMAL EXPANSION -- COPPER + TIN + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P., and Dickson, G.	43-6	528-1572	Bronze; 84.84% Cu; 14.93% Sn; 0.21% Pb	Telemicroscopes	
□	Hidnert, Peter	43-12	528-672	Leaded bronze; 80% Cu; 10% Sn; 10% Pb	Telemicroscopes	



LINEAR THERMAL EXPANSION -- COPPER + TIN + ZINC + X

LINEAR THERMAL EXPANSION -- COPPER + TIN + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P.	43-12	528-672	Sn–Zn Bronze: 90% Cu; 6.5% Sn; 2.0% Zn; 1.5% Pb	Telemicroscopes	
□	Ibid.	43-12	528-1212	Sn–Zn Bronze: 88% Cu; 10% Sn; 2% Zn	Same as above	Cast
△	Ibid.	43-12	528-1032	Sn–Zn Bronze: 88% Cu; 8% Sn; 4% Zn	Same as above	Same as above
◇	Ibid.	43-12	528-852	Sn–Zn Bronze 86.7% Cu, 11.2% Sn; 2.1% Zn	Same as above	Cast, annealed at 1373°F
▽	Ibid.	43-12	528-1032	Sn–Zn Bronze: 86.5% Cu; 11% Sn; 2.5% Zn	Same as above	Cast in green sand mold at about 2250°F

PROPERTIES OF POROUS COPPER-TIN MATERIALS

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 89% Cu	400 lb_m/ft^3	6.4 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

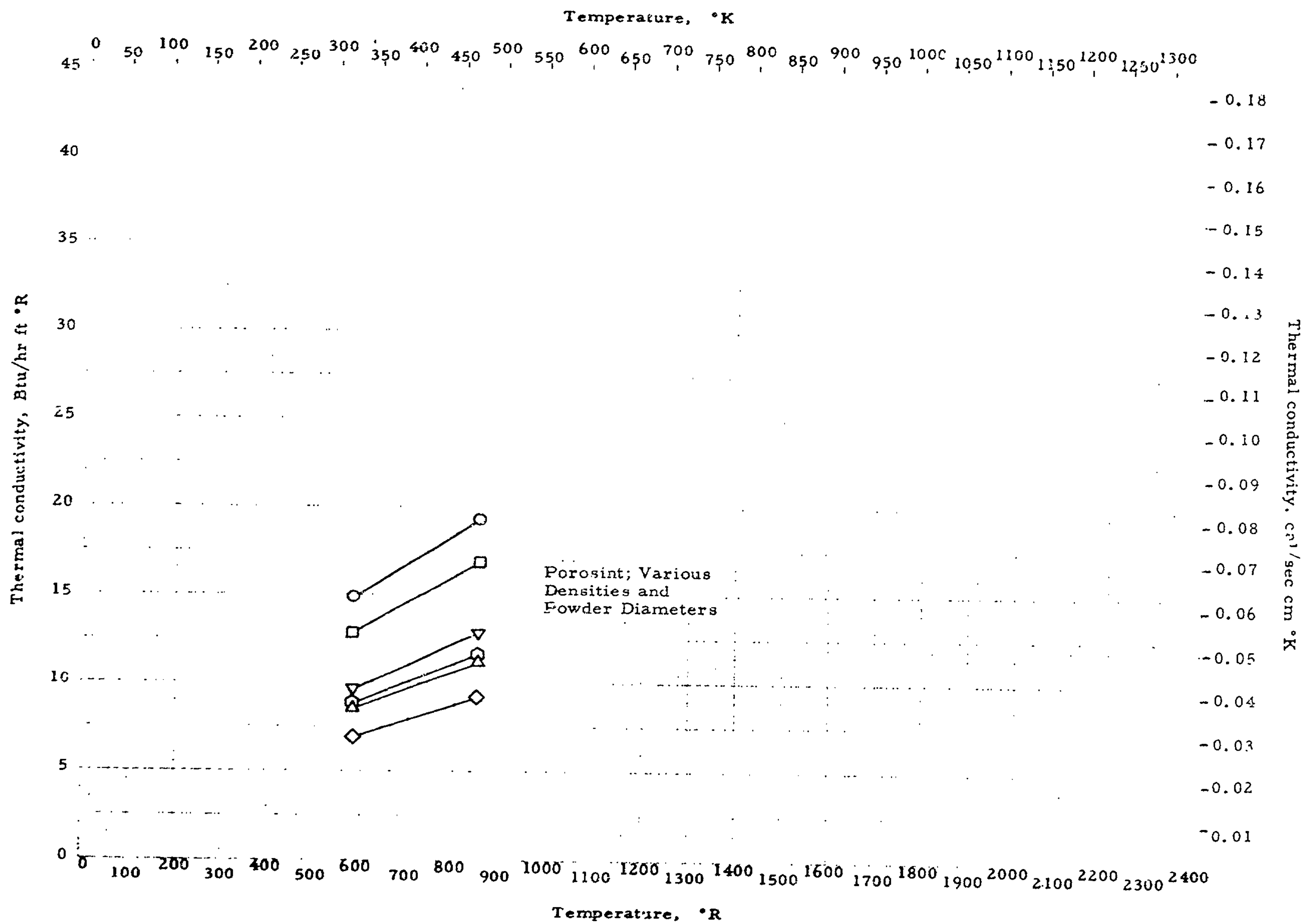
		lb_m/ft^3	g/cm^3
Density:	○	402	6.45
	□	393	6.30
	△	365	5.85
	◇	346	5.55
	▽	359	5.75
	⬡	343	5.50

Melting Point:	°R	°K
Heat of Fusion:	Btu/lb_m	cal/g
Heat of Vaporization:	Btu/lb_m	cal/g
Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF POROUS COPPER-TIN MATERIALS

REFERENCE INFORMATION

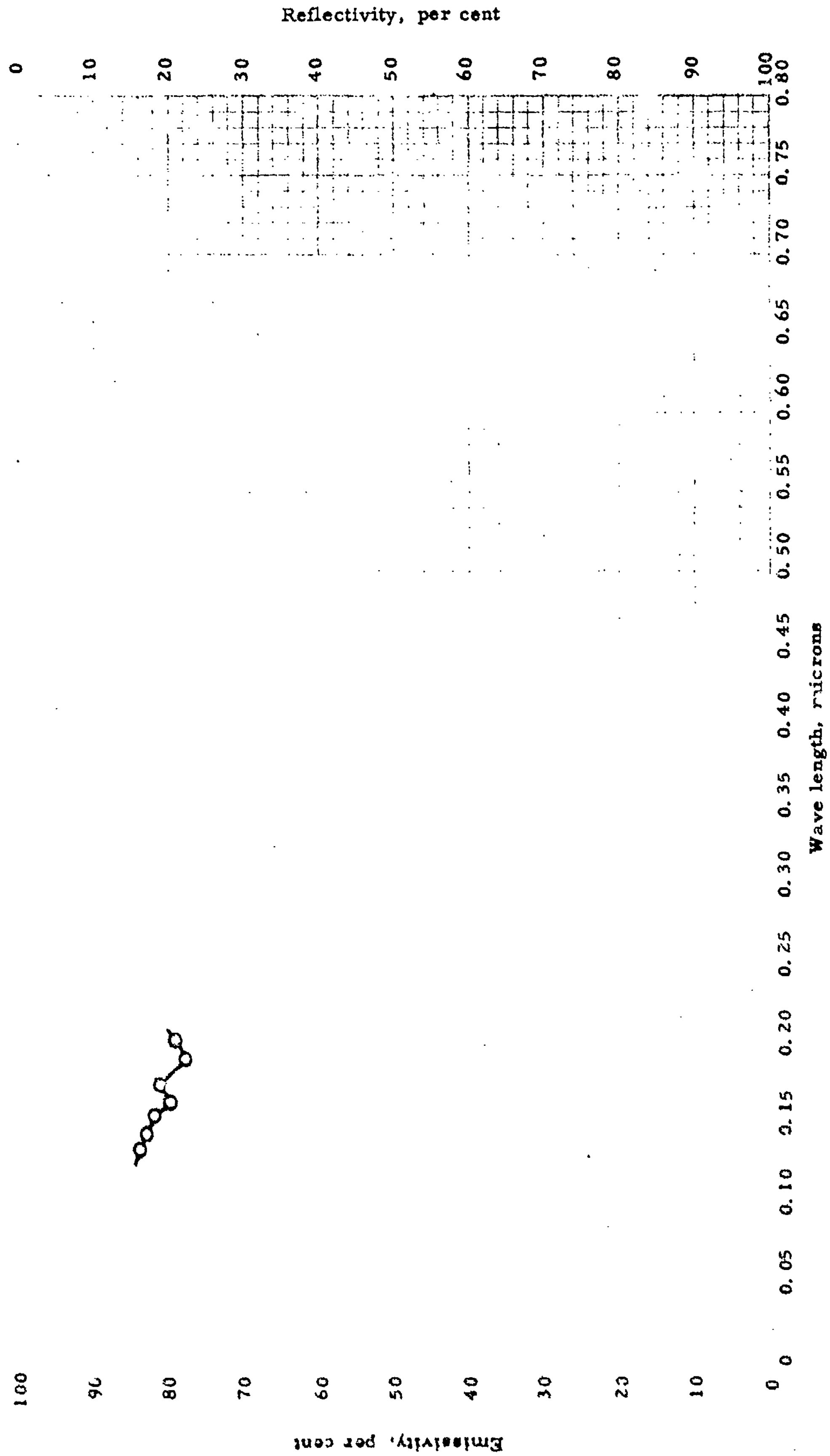
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grootenhuis, P., Powell, R. W. and Tye, R. P.	52-60	Room	Bronze; Nominal: 89% Cu, 11% Sn	ρ: not given	Porous bronze alloy prepared by powder metallurgy. Powder density 540 lb_m/ft^3. Powder diameter 0.00133 cm
□	Ibid.	52-60	Room	Same as above	ρ: same as above	Same preparation as above. Powder diameter 0.00493 cm
△	Ibid.	52-60	Room	Same as above	ρ: same as above	Same preparation as above. Powder diameter C.00493 cm
◇	Ibid.	52-60	Room	Same as above	ρ: same as above	Same preparation as above. Powder diameter 0.01275 cm
▽	Ibid	52-60	Room	Same as above	ρ: same as above	Same preparation as above. Powder diameter 0.02113 cm
○	Ibid.	52-60	Room	Same as above	ρ: same as above	Same preparation as above. Powder diameter 0.04000 cm



THERMAL CONDUCTIVITY -- COPPER + TIN

REFERENCE INFORMATION

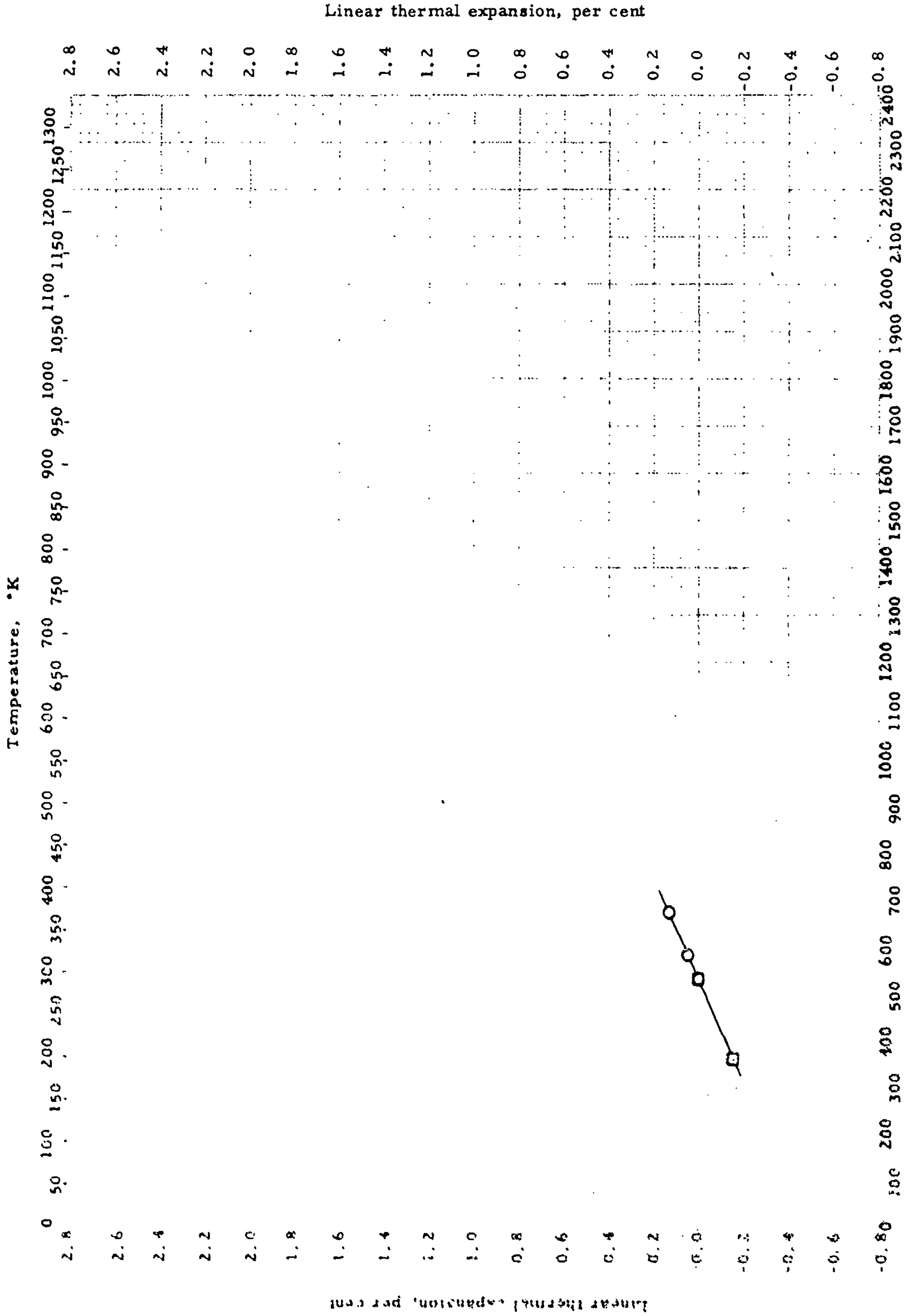
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grootenhuis, P., Powell, R. W., and Tye, R. P.	52-60	582-852	Porosint (Sintered Products Ltd.); 89% Cu; 11% Sn; ρ = 402.5 lb_m/ft^3	Comparative; bars	Sintered. Powder dia. = 0.00133 cm
□	Ibid.	52-60	582-852	Same as above: ρ = 393.1 lb_m/ft^3	Same as above	Sintered. Powder dia. = 0.00493 cm
△	Ibid.	52-60	582-852	Same as above; ρ = 365.0 lb_m/ft^3	Same as above	Sintered. Powder dia. = 0.00493 cm
◇	Ibid.	52-60	582-852	Same as above; ρ = 346.3 lb_m/ft^3	Same as above	Sintered. Powder dia. = 0.01275 cm
▽	Ibid.	52-60	582-852	Same as above; ρ = 358.8 lb_m/ft^3	Same as above	Sintered. Powder dia. = 0.02113 cm
○	Ibid.	52-60	582-852	Same as above; ρ = 343.2 lb_m/ft^3	Same as above	Sintered. Powder dia. = 0.04000 cm



SPECTRAL EMISSIVITY -- COPPER + TIN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Johnson, B. K.	41-20	Room	Speculum. Nominal: 68.25% Cu; 31.75% Sn	Compared intensity of direct and reflected spectral lines on photographic plate	Polished with MgO. Surface tarnished considerably after two months

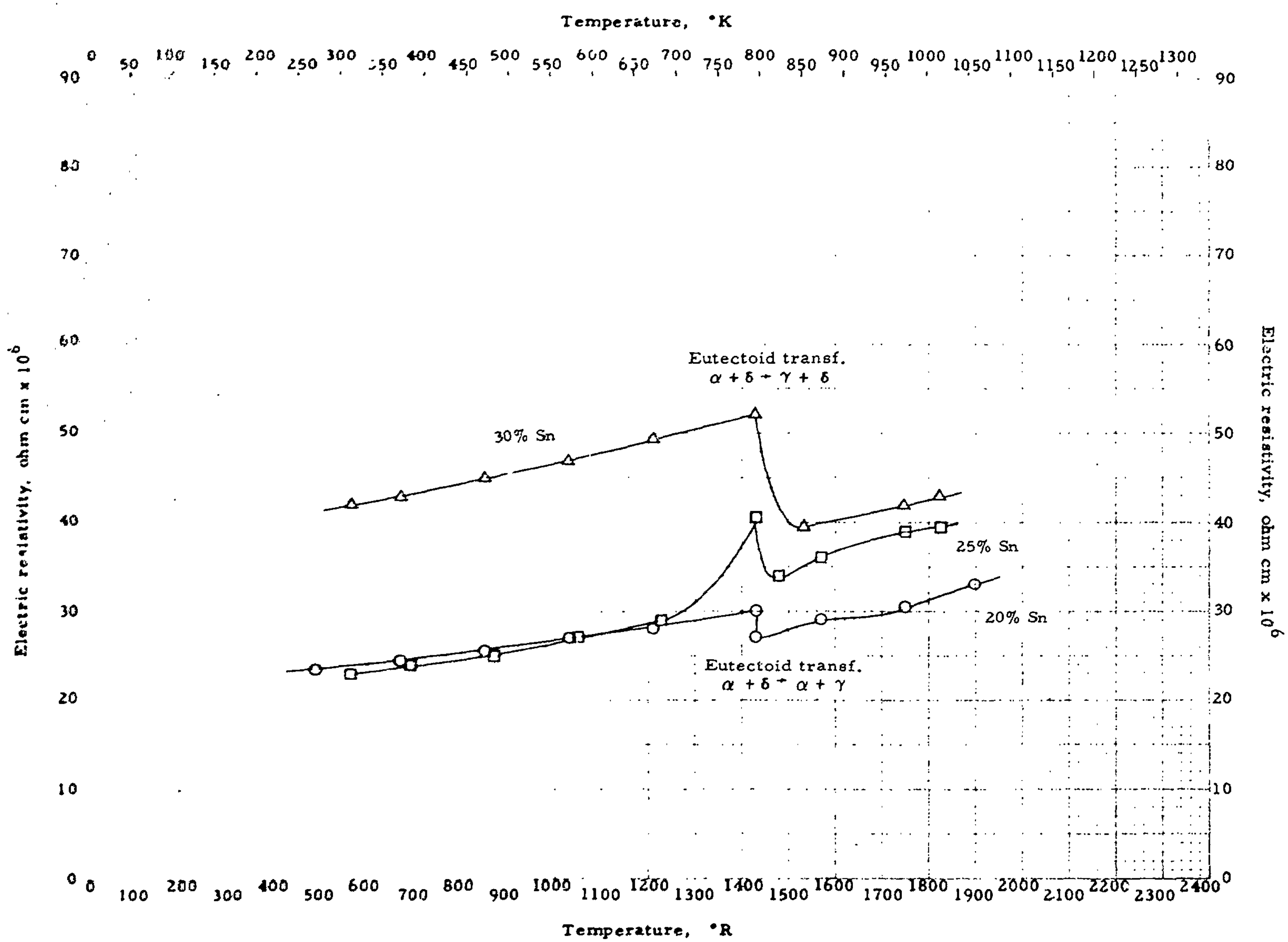


LINEAR THERMAL EXPANSION -- COPPER + TIN

LINEAR THERMAL EXPANSION -- COPPER + TIN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P.	43-12	528-672	Sn-Zn Bronze: 98.6% Cu; 1.3% Sn; 0.02% Fe	Telemicroscopes	Hot rolled, annealed
□	Perry, S.	45-6	360-528	Phosphor Bronze: 92% Cu; 8% Sn	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%

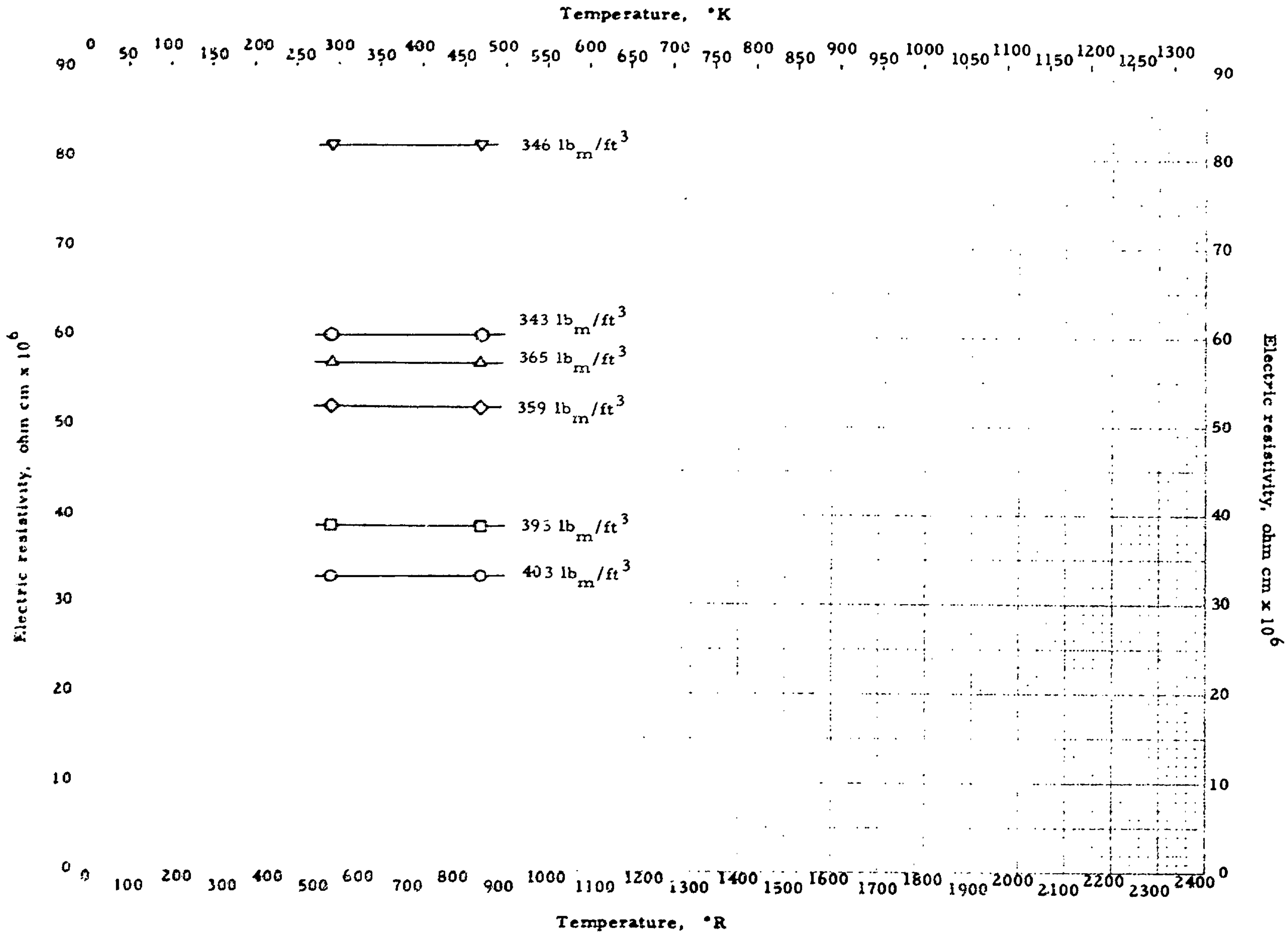


ELECTRIC RESISTIVITY -- COPPER + TIN

ELECTRIC RESISTIVITY -- COPPER + TIN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pecijare, O. and Janssen, S.	57-99	492-1896	Nominal: 80% Cu; 20% Sn	Not given	
□	Ibid.	57-99	492-1896	Nominal: 75% Cu; 25% Sn	Same as above	
△	Ibid.	57-99	492-1896	Nominal: 70% Cu; 30% Sn	Same as above	

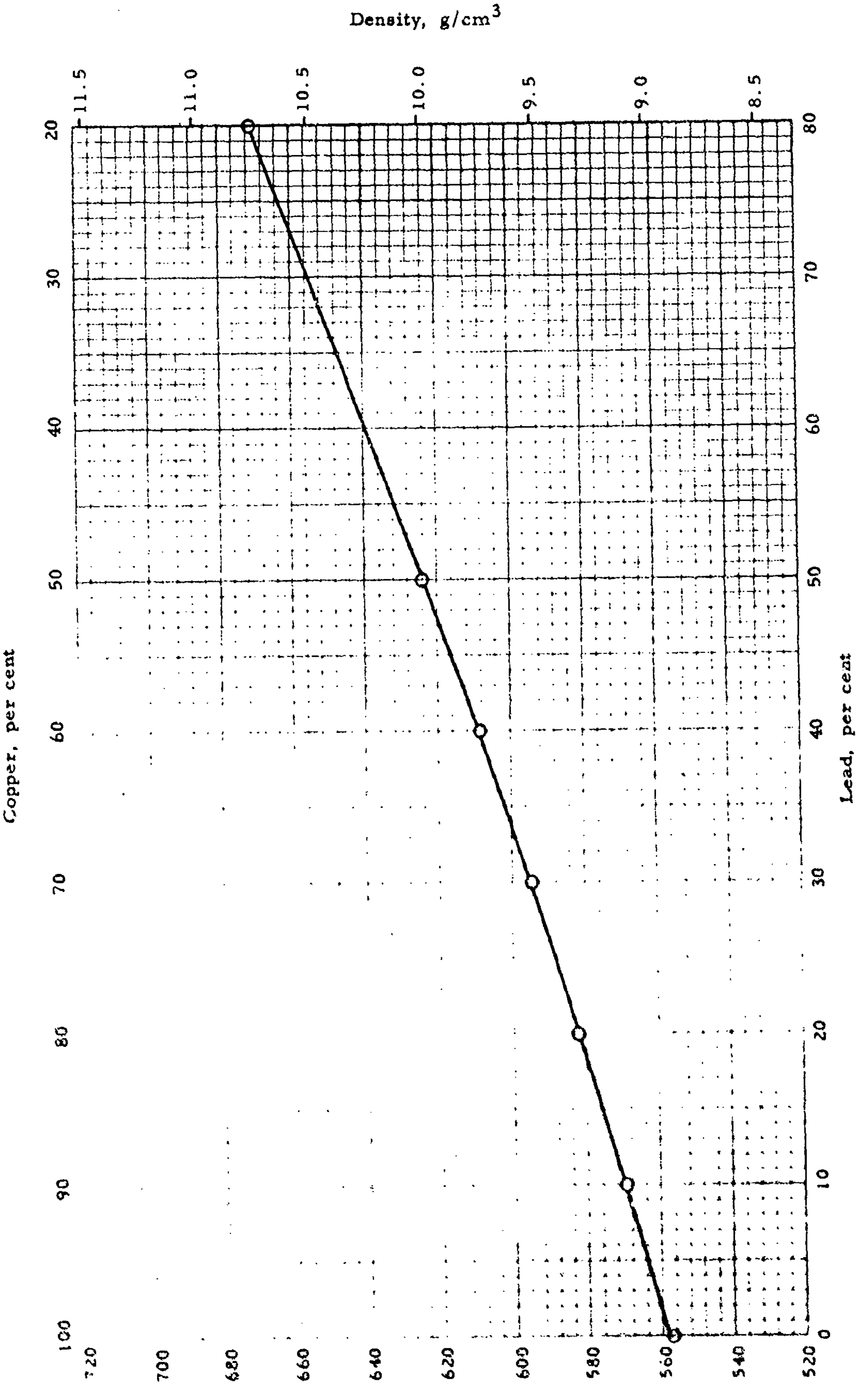


ELECTRIC RESISTIVITY -- POROUS COPPER - TIN MATERIALS

ELECTRIC RESISTIVITY -- POROUS COPPER - TIN MATERIALS

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grootenhuis, P., Powell, R. W., and Tye, R. P.	52-60	528-852	Bronze. Nominal: 89% Cu, 11% Sn. ρ = 403 lb_m/ft^3	Potential drop	Made from spherical shaped powder produced by atomization process; powder ρ = 543 lb_m/ft^3; Porosint Sintered Products Ltd.
□	Ibid.	52-60	528-852	Same as above; ρ = 393 lb_m/ft^3	Same as above	Same as above
△	Ibid.	52-60	528-852	Same as above, ρ = 365 lb_m/ft^3	Same as above	Same as above
◇	Ibid.	52-60	528-852	Same as above ρ = 359 lb_m/ft^3	Same as above	Same as above
▽	Ibid.	52-60	528-852	Same as above, ρ = 346 lb_m/ft^3	Same as above	Same as above
○	Ibid.	52-60	528-852	Same as above, ρ = 343 lb_m/ft^3	Same as above	Same as above

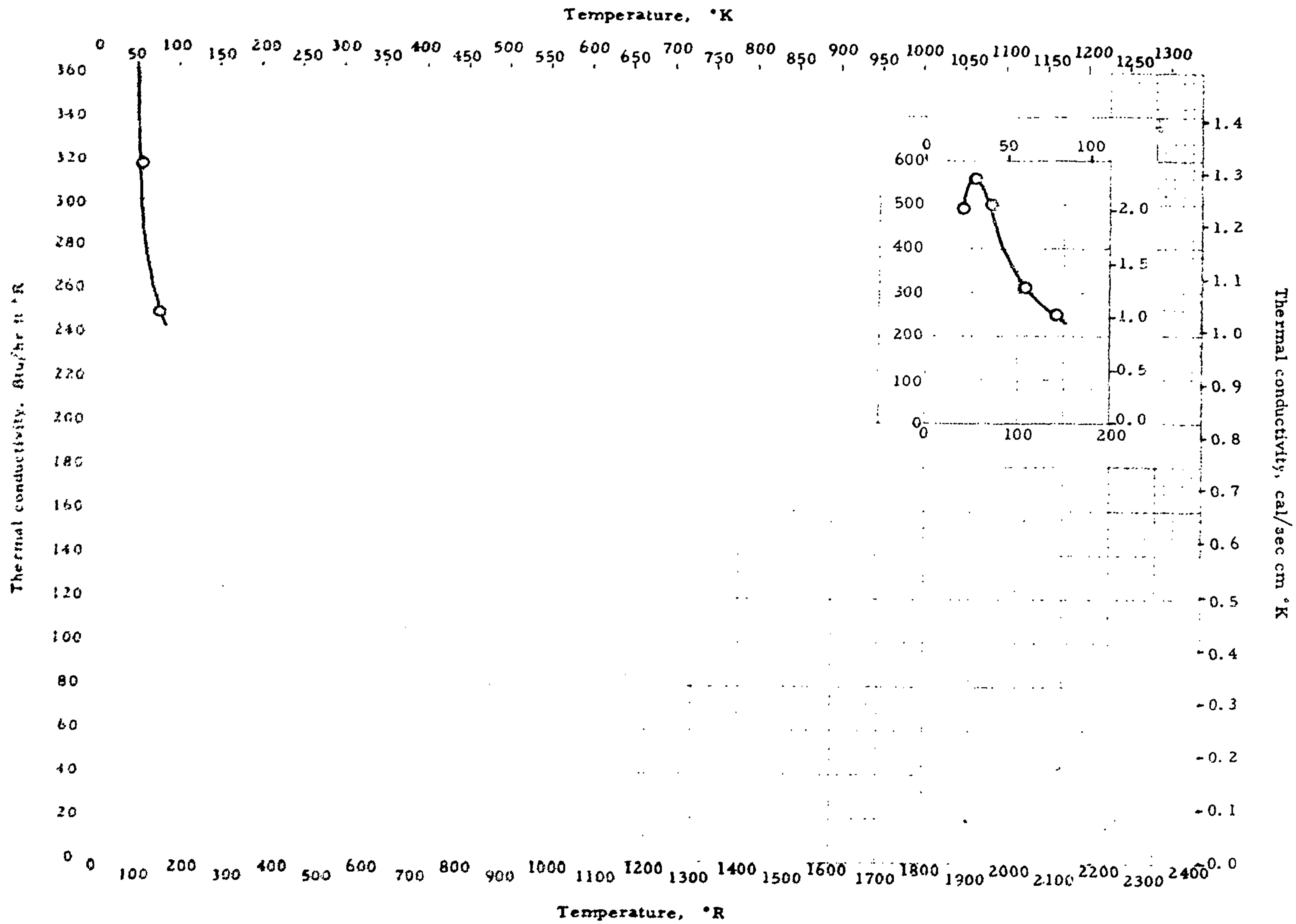


DENSITY -- COPPER + LEAD

DENSITY -- COPPER + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Peizel, F.	57-80	Room	0 - 80% Pb	Weight in air and in water	

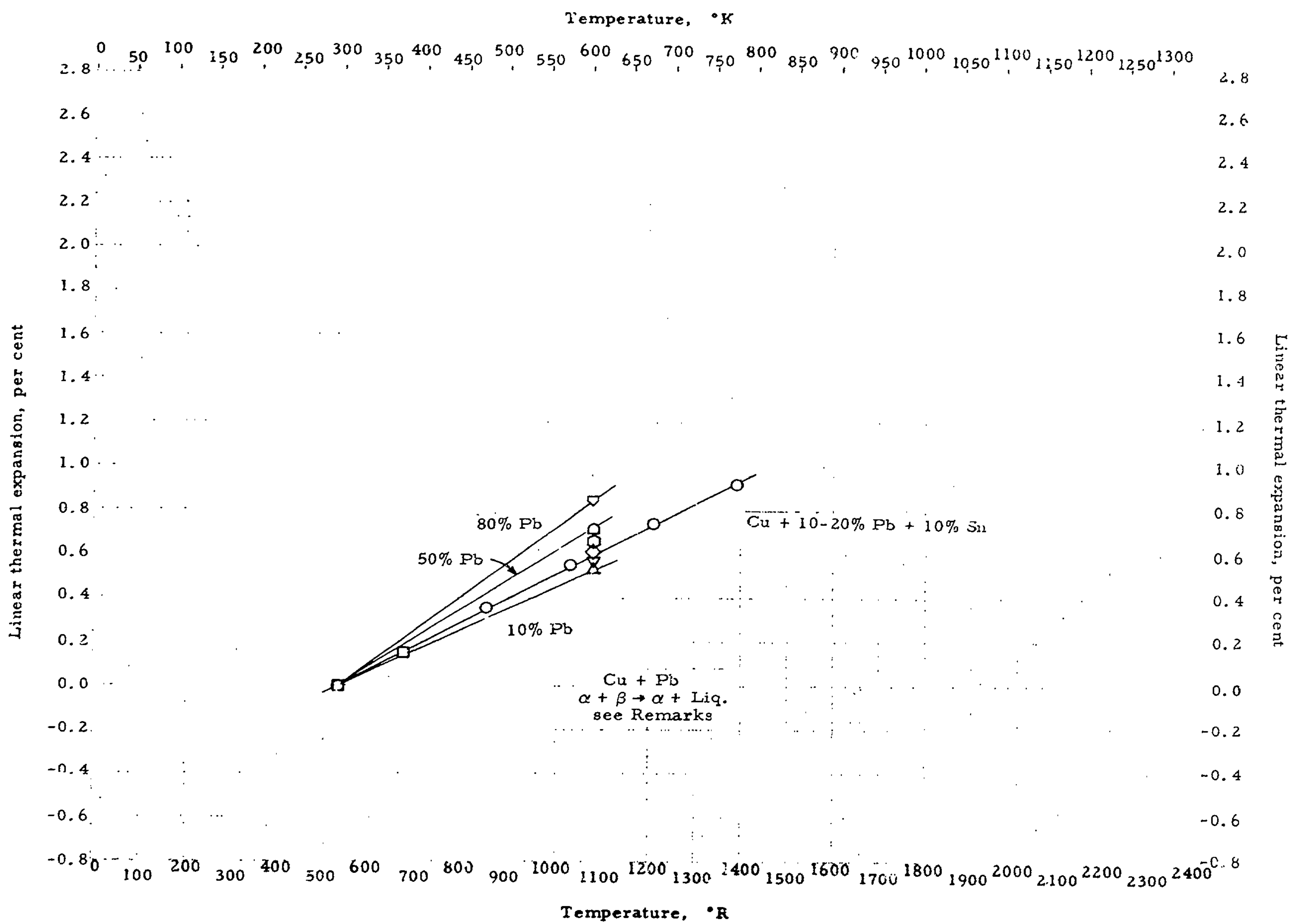


THERMAL CONDUCTIVITY -- COPPER + LEAD

THERMAL CONDUCTIVITY -- COPPER + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L. and Coffin, D. O.	55-120	40-144	98.94% Cu, 1.04% Pb	Axial heat flow in rod; guarded heat source and sample	Free machining copper; commercial hard drawn temper

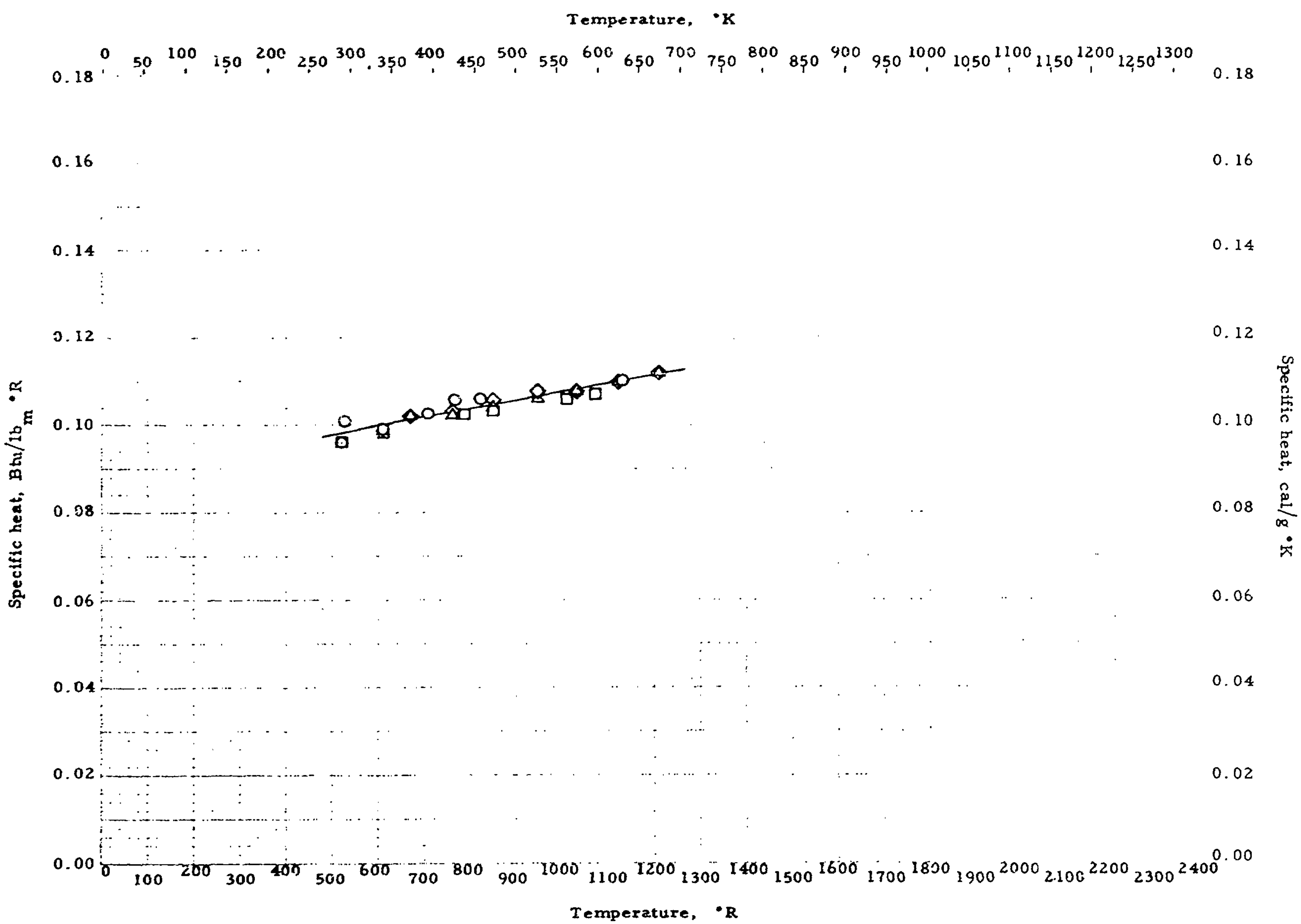


LINEAR THERMAL EXPANSION -- COPPER + LEAD + X

LINEAR THERMAL EXPANSION -- COPPER + LEAD + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P.	43-12	528-1392	Leaded bronze; 70% Cu; 21% Pb; 9% Sn	Telemicroscopes	
□	Ibid.	43-12	528-672	Leaded bronze; 80% Cu; 10% Pb; 10% Sn	Same as above	
△	Pelzel, E.	57-80	528-1079	90% Cu; 10% Pb	Dilatometer	$\alpha + \beta \rightarrow \alpha$ + Liq. at 326°C. $\Delta L/L$ at 326°C = 0
◇	Ibid.	57-80	528-1079	80% Cu; 20% Pb	Same as above	Same as above; $\Delta L/L$ at 326°C = -0.043%
▽	Ibid.	57-80	528-1079	70% Cu; 30% Pb	Same as above	Same as above; $\Delta L/L$ at 326°C = -0.015%
⬡	Ibid.	57-80	528-1079	60% Cu; 40% Pb	Same as above	Same as above; $\Delta L/L$ at 326°C = -0.07%
◠	Ibid.	57-80	528-1079	50% Cu; 50% Pb	Same as above	Same as above; $\Delta L/L$ at 326°C = -0.18%
♡	Ibid.	57-80	528-1079	20% Cu; 80% Pb	Same as above	Same as above; $\Delta L/L$ at 326°C not given

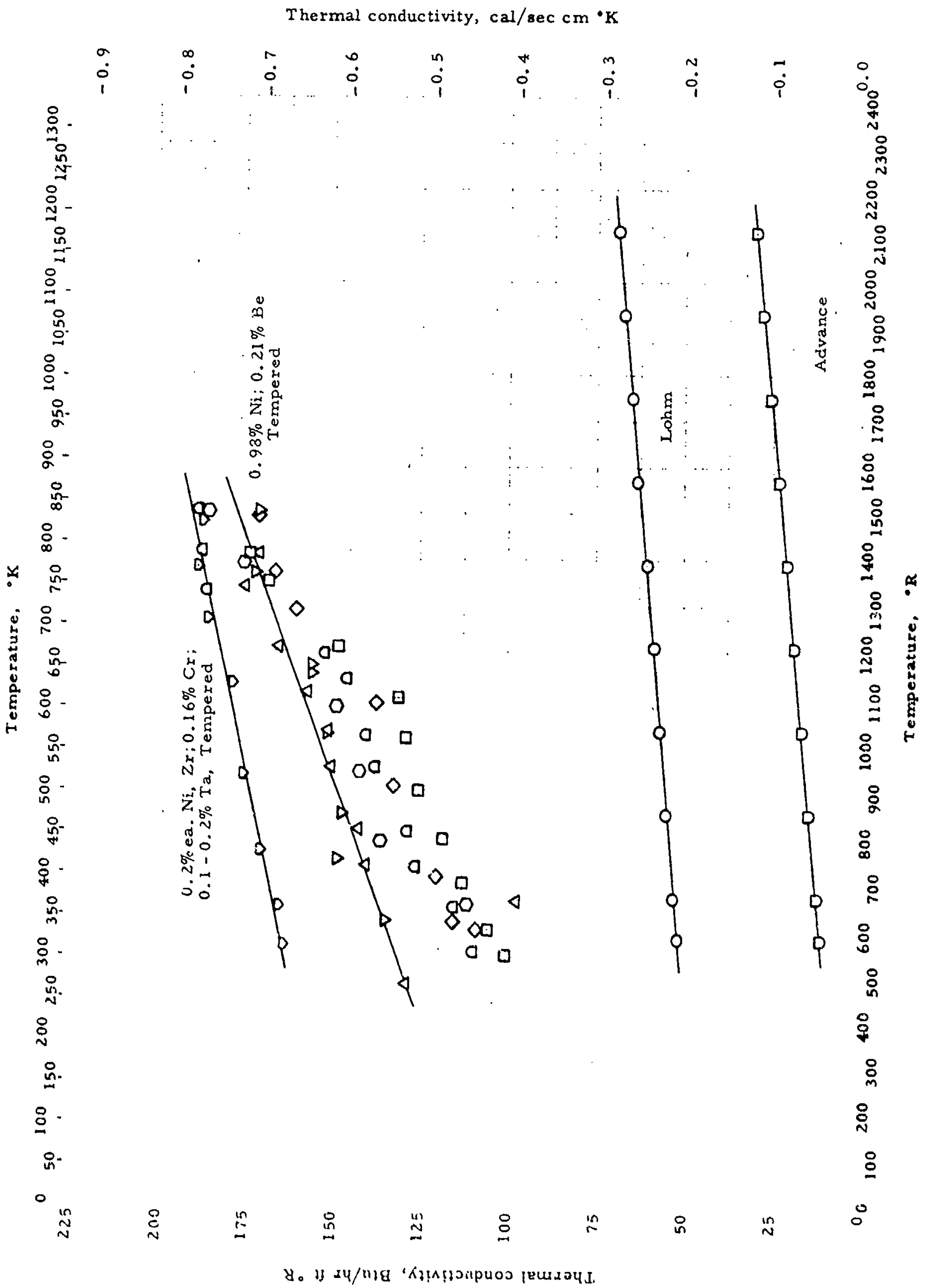


SPECIFIC HEAT -- COPPER + NICKEL

SPECIFIC HEAT -- COPPER + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Persoz, B.	40-4	520-1128	50% Cu; 50% Ni	Guarded sample	Auth. est. accuracy ± 0.5%; run in vacuum
□	Ibid.	40-4	520-1070	75% Cu; 25% Ni	Same as above	Same as above
△	Hirano, K., Maniwa, H., Takagi, Y.	55-29	672-1212	75% Cu; 25% Ni	Not given, data indicate use of a direct method	Quenched from 800°C annealed 2000 hr. at 130°C
◇	Ibid.	55-29	672-1212	Same as above	Same as above	Cooled from 600°C at 3°C/min.

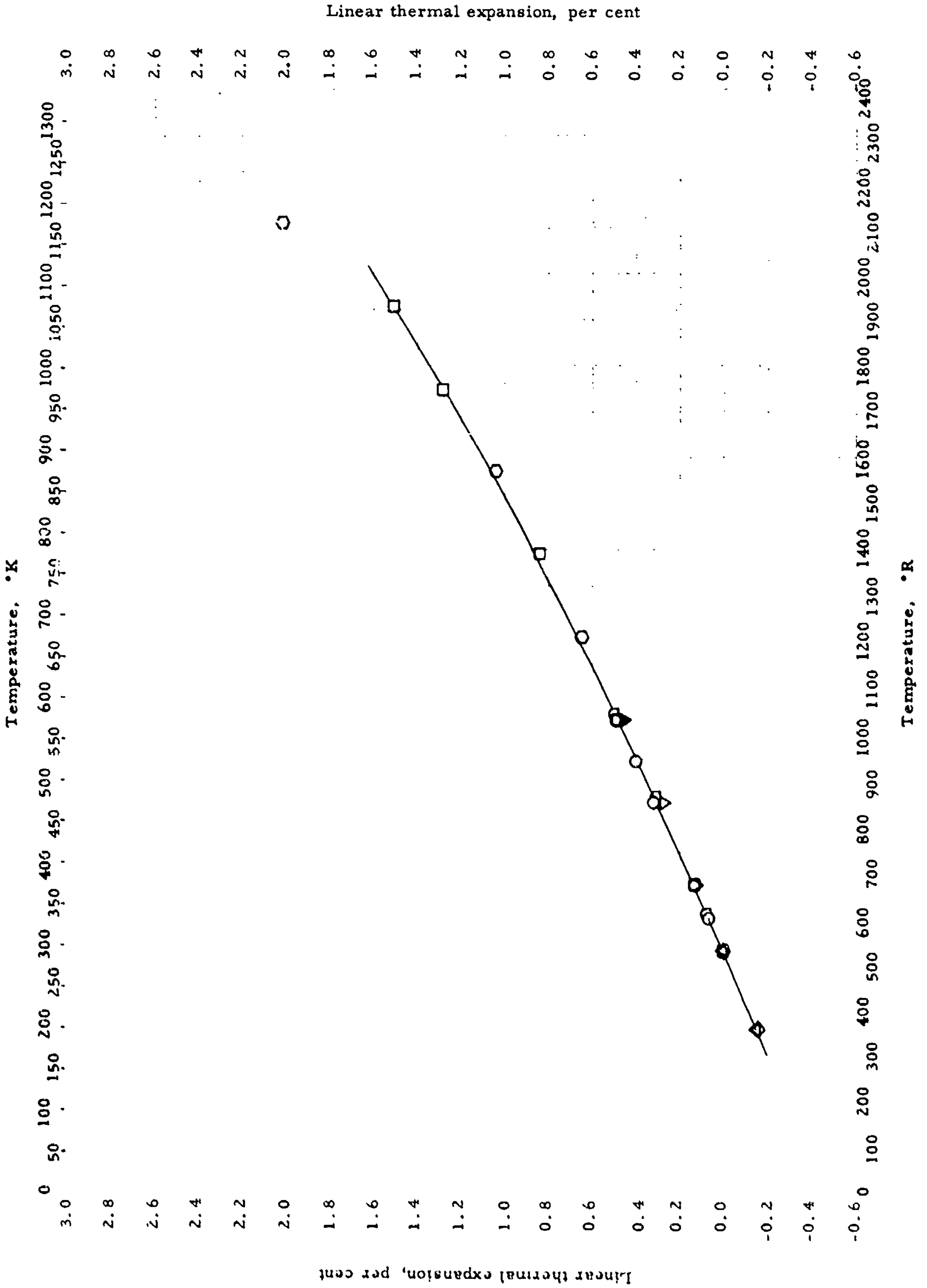


THERMAL CONDUCTIVITY -- COPPER + NICKEL + X

THERMAL CONDUCTIVITY -- COPPER + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Silverman, L.	53-2	582-2112	Lohm: 93.4% Cu; 6.05% Ni; 0.01% ea. Mn, Si.	Comparative; rods	Used lead for primary standard, "Advance" (Cu alloy) for working standard
□	Mikryukov, V. E.	56-71	544-1411	0.98% Ni; 0.21% Be	Temp. distribution along resistance heated rod	Normalized
△	Ibid.	56-71	544-1411	Same as above	Same as above	Tempered after quenching
◇	Ibid.	56-71	560-1496	0.90% Ni; 0.18% Be	Same as above	Normalized
▽	Ibid.	56-71	617-1504	0.62% Ni; 0.14% Be	Same as above	Same as above
○	Ibid.	56-71	655-1504	0.55% Ni; 0.25% Zr; 0.107% Be	Same as above	Same as above
⌂	Ibid.	56-71	560-1503	0.2% ea. Ni, Zr; 0.16% Cr; 0.1-0.2% Ta	Same as above	Same as above
▽	Ibid.	56-71	565-1489	Same as above	Same as above	Tempered after quenching
▢	Silverman, L.	53-2	582-2112	"Advance": 54.79% Cu; 44.04% Ni; 1.20% Mn; 0.035% C; 0.003% Si	Comparative; rods	

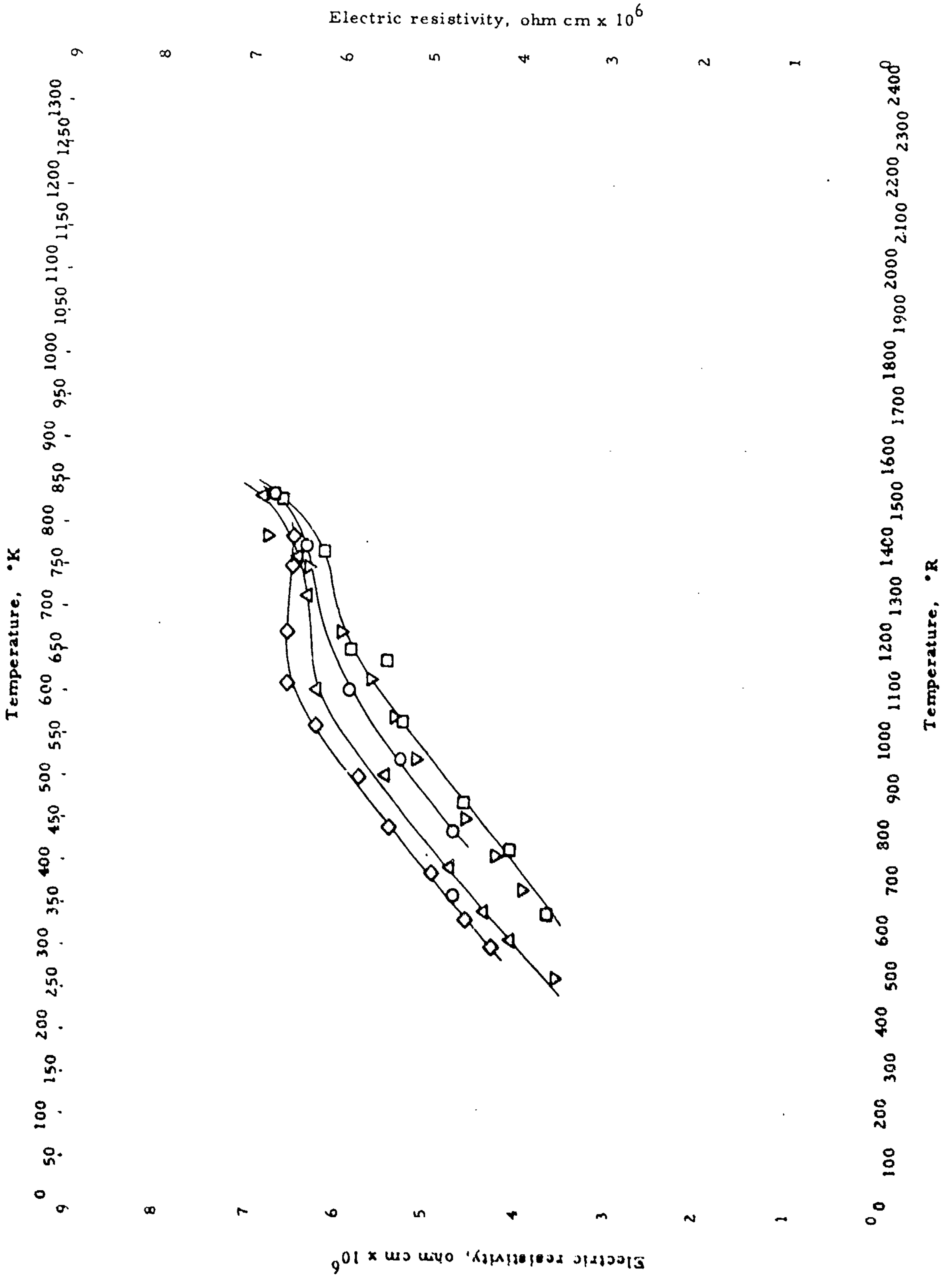


LINEAR THERMAL EXPANSION -- COPPER + NICKEL + X

LINEAR THERMAL EXPANSION -- COPPER + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
□	Hidnert, P. and Dickson, G.	43-6	528-1932	Tempaloy 836: 96% Cu; 3% Ni; 0.61% Si; 0.12% Fe	Telemicroscopes sighting on wires supporting sample	Avg. for 4 samples: cast at 1200°C; cast at 1200°C, annealed; annealed and quenched; cold worked
○	Hidnert, P. and Krider, H. S.	47-7	528-1032	Phosphor bronze: 98.47% Cu; 1.19% Ni; 0.26% P	Telemicroscopes sighting on wires supporting sample	Quenched from 1450°F, aged 1 hr. at 800°F and 18 months at room temp.
△	Perry, Stanley	45-6	360-528	Super nickel No. 701; 70.0% Cu; 30% Ni	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
◇	Ibid.	45-6	360-528	Nickel Silver No. 719; 65.0% Cu; 18.0% Ni; 17.8% Zn	Same as above	Same as above
▽	Hidnert, P. and Dickson, G.	43-6	528-1032	Admiralty Nickel: 69.57% Cu; 28.70% Ni; 0.91% Sn	Telemicroscopes sighting on wires supporting sample	Extruded rod; finished hard
○	Ibid.	43-6	852-1932	68% Cu; 20% Ni; 12% Sn	Same as above	Cast bar
◠	Hidnert, P. and Krider, H. S.	47-7	528-1032	69.42% Cu; 29.93% Ni; 0.53% Mn; 0.07% Fe; 0.05% Zn	Telemicroscopes sighting on wires supporting sample	Annealed at 1300°F

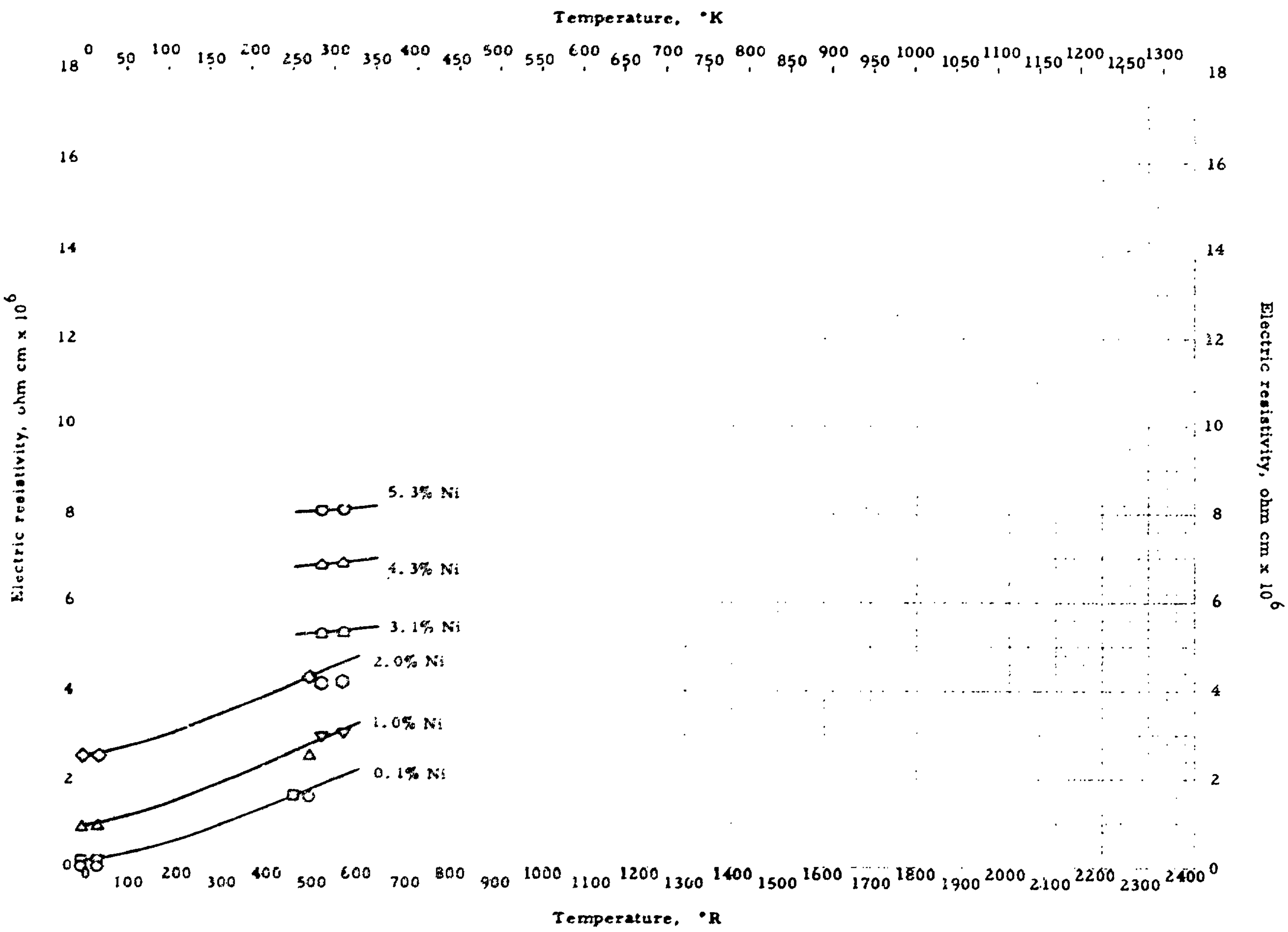


ELECTRIC RESISTIVITY -- COPPER + NICKEL + BERYLLIUM + X

ELECTRIC RESISTIVITY -- COPPER + NICKEL + BERYLLIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V.E.	56-71	655-1504	0.55% Ni; 0.107% Be; 0.25% Zr	Potential drop	Normalized
□	Ibid.	56-71	617-1504	0.62% Ni; 0.14% Be	Same as above	Same as above
△	Ibid.	56-71	560-1496	0.90% Ni; 0.18% Be	Same as above	Same as above
◇	Ibid.	56-71	544-1411	0.98% Ni; 0.21% Be	Same as above	Same as above
▽	Ibid.	56-71	544-1411	Same as above	Same as above	Quenched, tempered



ELECTRIC RESISTIVITY -- COPPER + NICKE_ + X

ELECTRIC RESISTIVITY -- COPPER + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Los, G.J.	57-132	2-492	99.98% Cu; 0.02% Ni	Not described here, refers to others	Made from pure components in vac.
□	Ibid.	57-132	2-492	99.86% Cu; 0.14% Ni	Same as above	Same as above
△	Ibid.	57-132	2-492	99.28% Cu; 0.72% Ni	Same as above	Same as above
◇	Ibid.	57-132	2-492	97.94% Cu; 2.06% Ni	Same as above	Same as above
▽	Pollock, D.D. and Finch, D.I.	56-114	519-554	1.029% Ni; <0.008% Mg; <0.004% Si <0.001% ea. of others	Kelvin double bridge	Auth. also report relative resistance data for many alloys in Cu + Mn + Ni + Fe system
○	Ibid.	56-114	519-564	2.012% Ni; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
◒	Ibid.	56-114	519-564	3.101% Ni; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
◓	Ibid.	56-114	519-564	4.327% Ni; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
◑	Ibid.	56-114	519-564	5.286% Ni; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above

PROPERTIES OF COPPER + ALUMINUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 12% Al	460 lb_m/ft^3	7.3 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

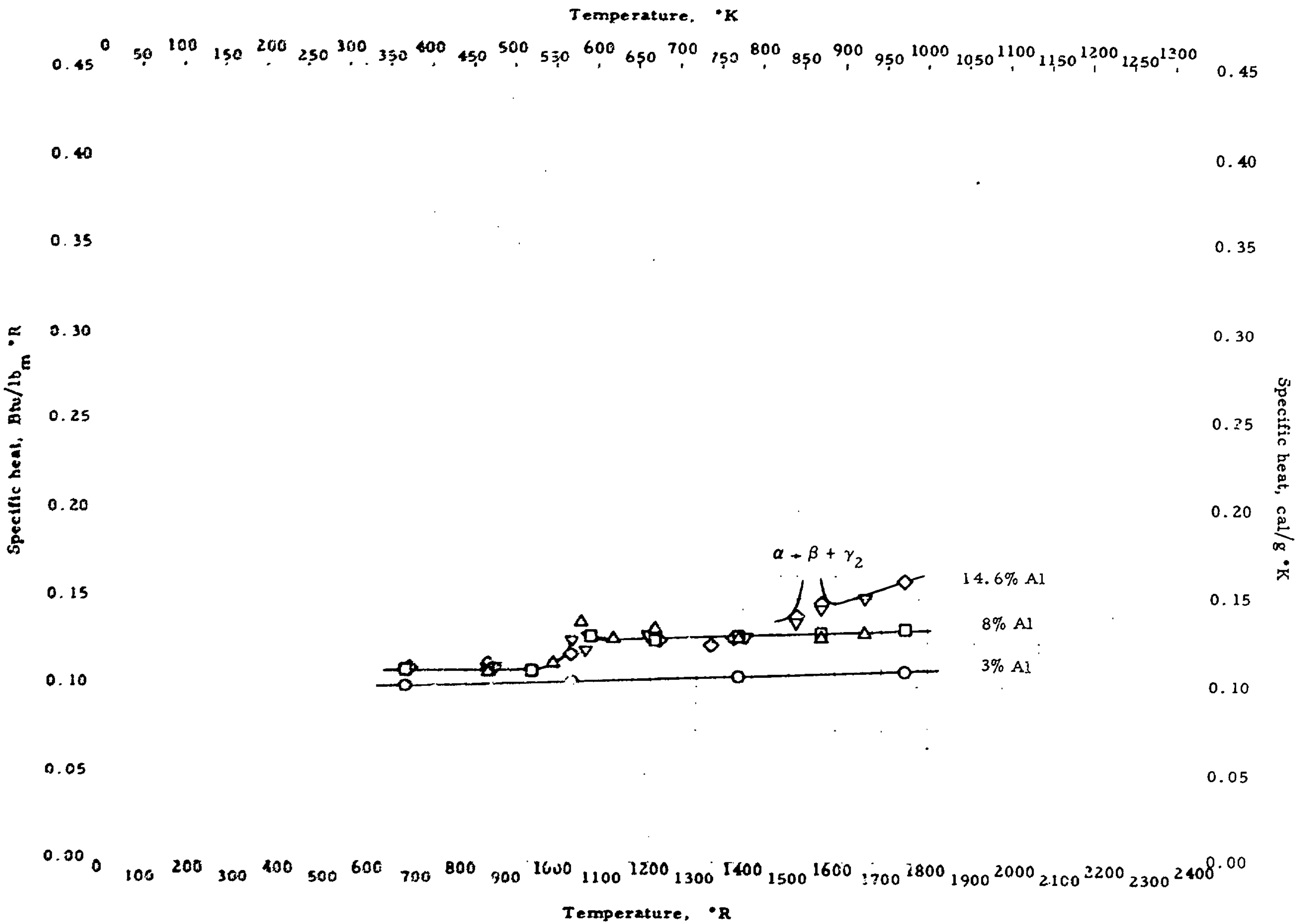
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	455	7.28
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF COPPER + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Le Roux, R.	53-128	Room	11.95% Al	ρ : not given	

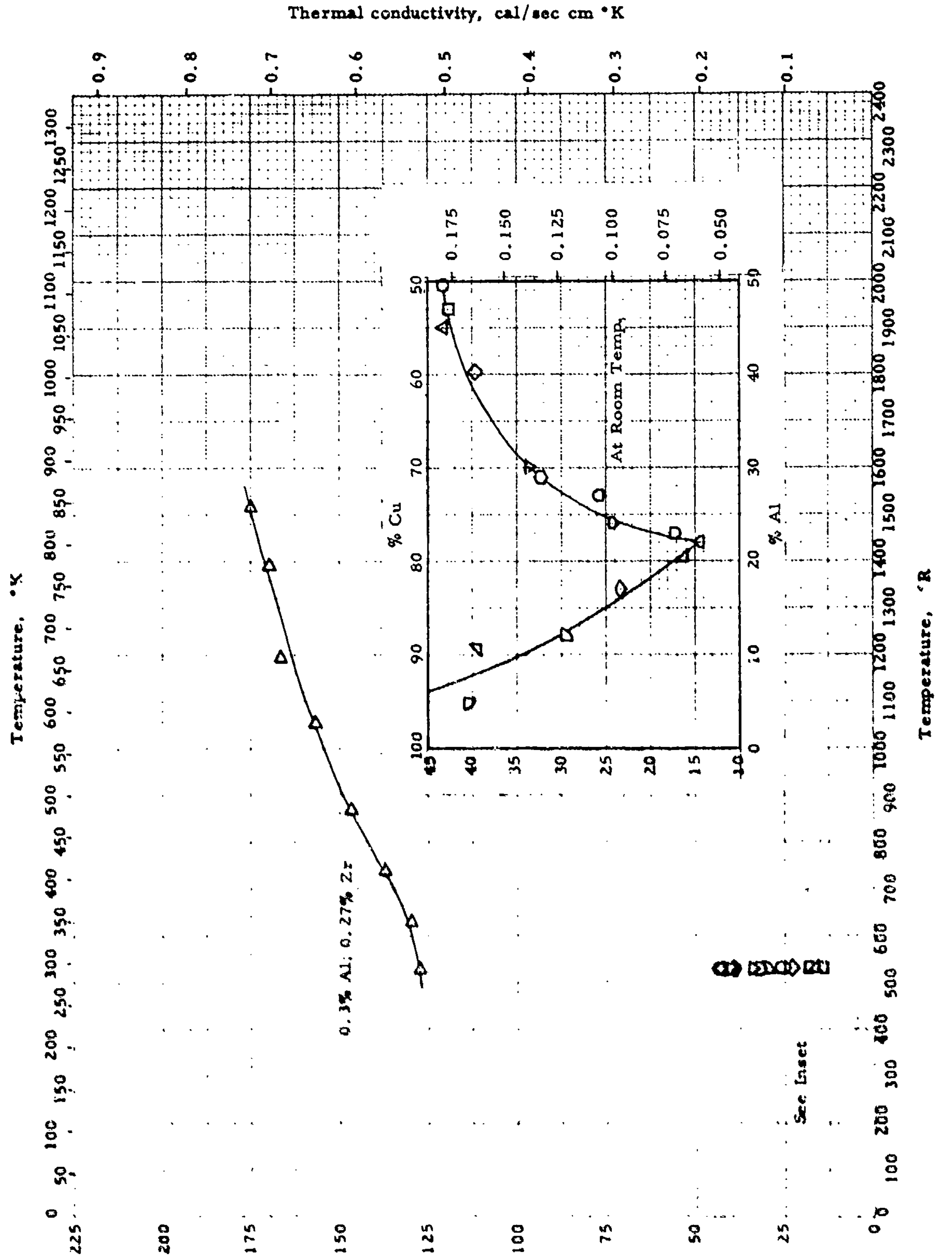


SPECIFIC HEAT -- COPPER + ALUMINUM

SPECIFIC HEAT -- COPPER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Masumoto, H., Saito, H. and Takahashi, M.	54-60 also 55-121	672-1752	96.87% Cu; 3.13% Al; prepared from Cu containing 0.02% ea. Zn, S; 0.01% ea. Pb, As, Sb; and Al containing 0.42% Si, 0.14% Fe; 0.04% Zn; 0.05% Cu, 0.001% S, trace Mn	Comparative; rate of cooling of sample compared to standard (Cu) under same conditions	Cond. 1: Annealed 1 hr. at 700°C in vacuum, cooled at 30°C/hr. to room temp; reheated for 3.5 to 10 hr. at 550°C, cooled slowly
□	Ibid.	54-60	672-1752	91.95% Cu; 8.05% Al; raw materials same as above	Same as above	Same as above
△	Ibid.	54-60	672-1752	Same as above	Same as above	Cond. 2: Same as cond. 1, then baked 220 hr. at 210°C
◇	Ibid.	54-60	672-1752	85.41% Cu; 14.59% Al; raw materials same as above	Same as above	Cond. 1
▽	Ibid.	54-60	672-1752	Same as above	Same as above	Cond. 2
						Auth. gives similar data for increments of 1% Al for alloys 3 - 14% Al Peak in curve noted at 300 - 340°C for Al>4%; anomaly greatest for 8%<Al<9%

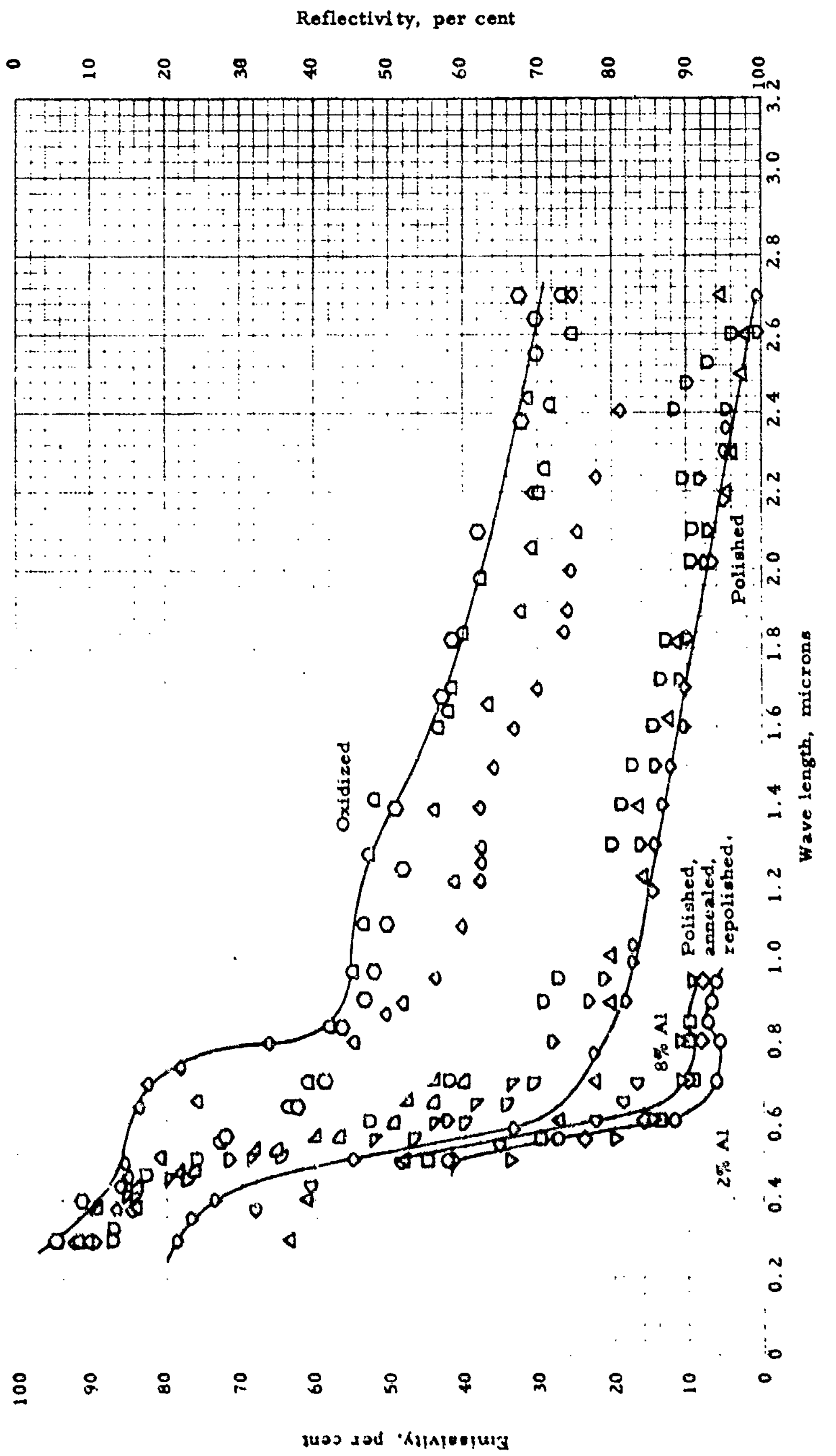


THERMAL CONDUCTIVITY -- COPPER + ALUMINUM

THERMAL CONDUCTIVITY -- COPPER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Aliev, N. A.	56-33	Room	50.45% Cu; 49.55% Al; raw materials electrolytically pure	Not given	Annealed 5 hr. near melting point, furnace cooled
□	Ibid.	56-33	Room	53.00% Cu; 47.00% Al; raw materials same as above	Same as above	Same as above
△	Ibid.	56-33	Room	55.00% Cu; 45.00% Al; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-33	Room	59.62% Cu; 40.38% Al; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-33	Room	69.99% Cu; 30.01% Al; raw materials same as above	Same as above	Same as above
○	Ibid.	56-33	Room	71.00% Cu; 29.00% Al; raw materials same as above	Same as above	Same as above
⌂	Ibid.	56-33	Room	73.00% Cu; 27.00% Al; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-33	Room	76.00% Cu; 24.00% Al; raw materials same as above	Same as above	Same as above
▢	Ibid.	56-33	Room	77.00% Cu; 23.00% Al; raw materials same as above	Same as above	Same as above
⌂	Ibid.	56-33	Room	78.00% Cu; 22.00% Al; raw materials same as above	Same as above	Same as above
◺	Ibid.	56-33	Room	79.58% Cu; 20.42% Al; raw materials same as above	Same as above	Same as above
♡	Ibid.	56-33	Room	83.00% Cu; 17.00% Al; raw materials same as above	Same as above	Same as above
▱	Ibid.	56-33	Room	88.00% Cu; 12.00% Al; raw materials same as above	Same as above	Same as above
◿	Ibid.	56-33	Room	89.22% Cu; 10.78% Al; raw materials same as above	Same as above	Same as above
◸	Ibid.	56-33	Room	95.00% Cu; 5.00% Al; raw materials same as above	Same as above	Same as above
▷	Mikryukov, V. E.	55-71	564-1535	0.3% Al; 0.27% Zr	Temp. distribution along resistance heated rod	Normalized

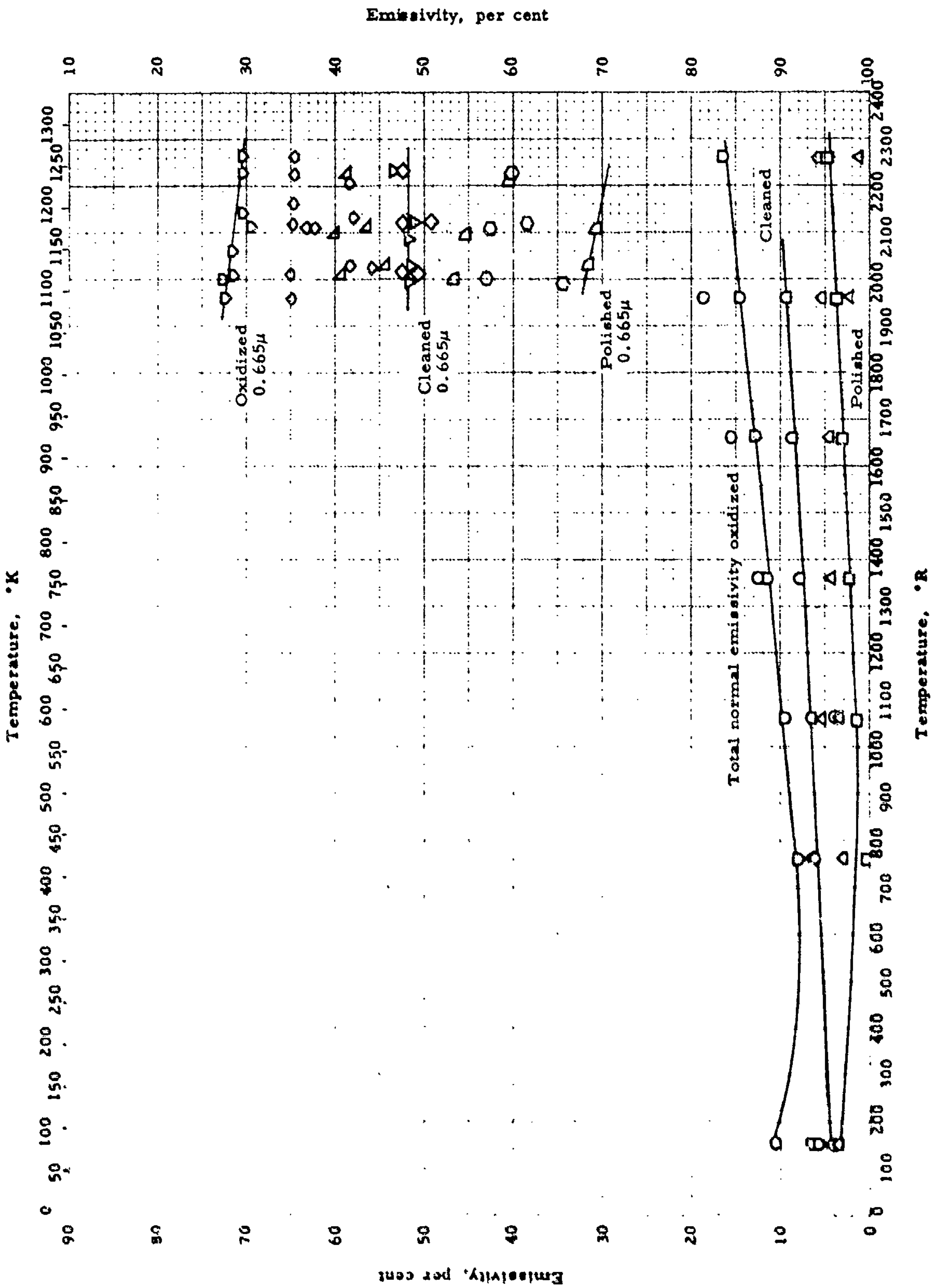


SPECTRAL EMISSIVITY -- COPPER + ALUMINUM + X

SPECTRAL EMISSIVITY -- COPPER + ALUMINUM + X

REFERENCE INFORMATION

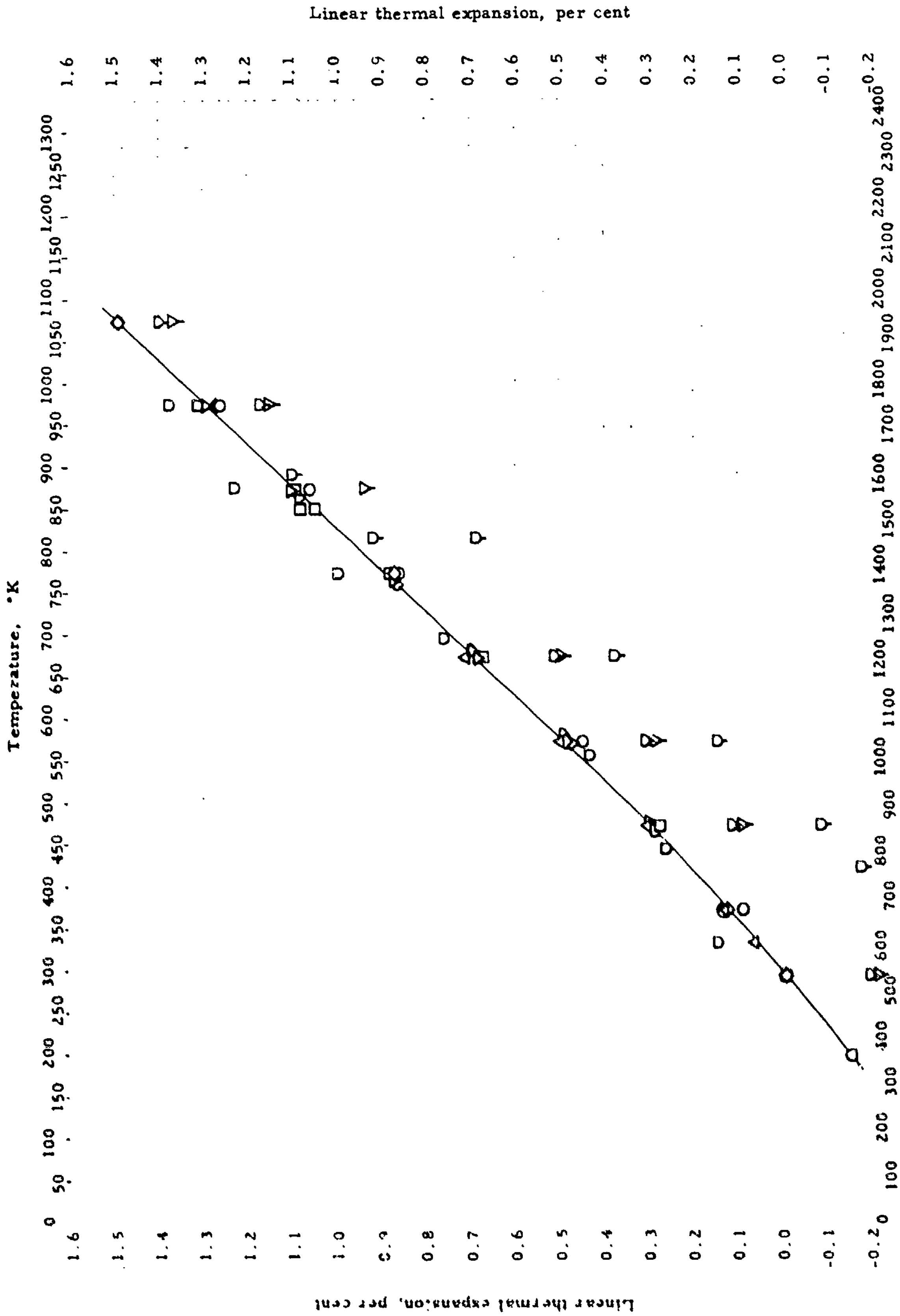
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	McPherson, L.	40-13	Room	Aluminum bronze 97.85% Cu; 2.095%	Spectral reflectivity (0.5 - 0.95 μ) method not given here, refers to others	Specimens were polished, annealed 70 - 75 hr just below M.P., then repolished
□	Ibid.	40-13	Room	Aluminum bronze 95.85% Cu; 4.25% Al	Same as above	Same as above
▽	Ibid.	40-13	Room	Aluminum bronze 94.94% Cu; 6.13% Al	Same as above	Same as above
◇	Ibid.	40-13	Room	Aluminum bronze 92.05% Cu; 8.17% Al	Same as above	Same as above
△	Betz, H. T., and Olson, O.H., et al.	57-8	Room	Aluminum bronze Fed Spec QQ-B-667 comp. 5 Nominal composition: 88.0-92.5% Cu; 6.0-8.0% Al; <3.5% Fe; <1.0% Mn	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Surface polished
○	Ibid.	57-8	Room	Same as above	Same as above	Surface as received
○	Ibid.	57-8	Room	Same as above	Same as above	Surface cleaned by detergent
△	Ibid.	57-8	Room	Same as above	Same as above	Surface oxidized 30 min. at red heat in air
□	Ibid.	57-8	Room	Aluminum bronze Fed Spec QQ-B-667 comp. 3. Nominal: 92-96% Cu; 4-7% Al; <0.5% Fe	Same as above	Surface as received
▽	Ibid.	57-8	Room	Same as above	Same as above	Surface cleaned by detergent
◇	Ibid.	57-8	Room	Same as above	Same as above	Surface polished
◇	Ibid.	57-8	Room	Same as above	Same as above	Surface oxidized 30 min. at red heat in air
△	Betz, H. T., Olson, O.H., et al.	56-66	Room	Aluminum bronze, Fed Spec. QQ-B-667; 4-8% Al	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Surface as received. Parallel to rolling direction
□	Ibid.	56-66	Room	Same as above	Same as above	Surface as received. Perpendicular to rolling direction
▽	Ibid.	56-66	Room	Same as above	Same as above	Surface cleaned by detergent. Parellel to rolling direction
▽	Ibid.	56-66	Room	Same as above	Same as above	Surface cleaned by detergent. Perpendicular to rolling direction
◁	Ibid.	56-66	Room	Same as above	Same as above	Surface polished



EMISSIVITY -- COPPER + ALUMINUM + X

REFERENCE INFORMATION

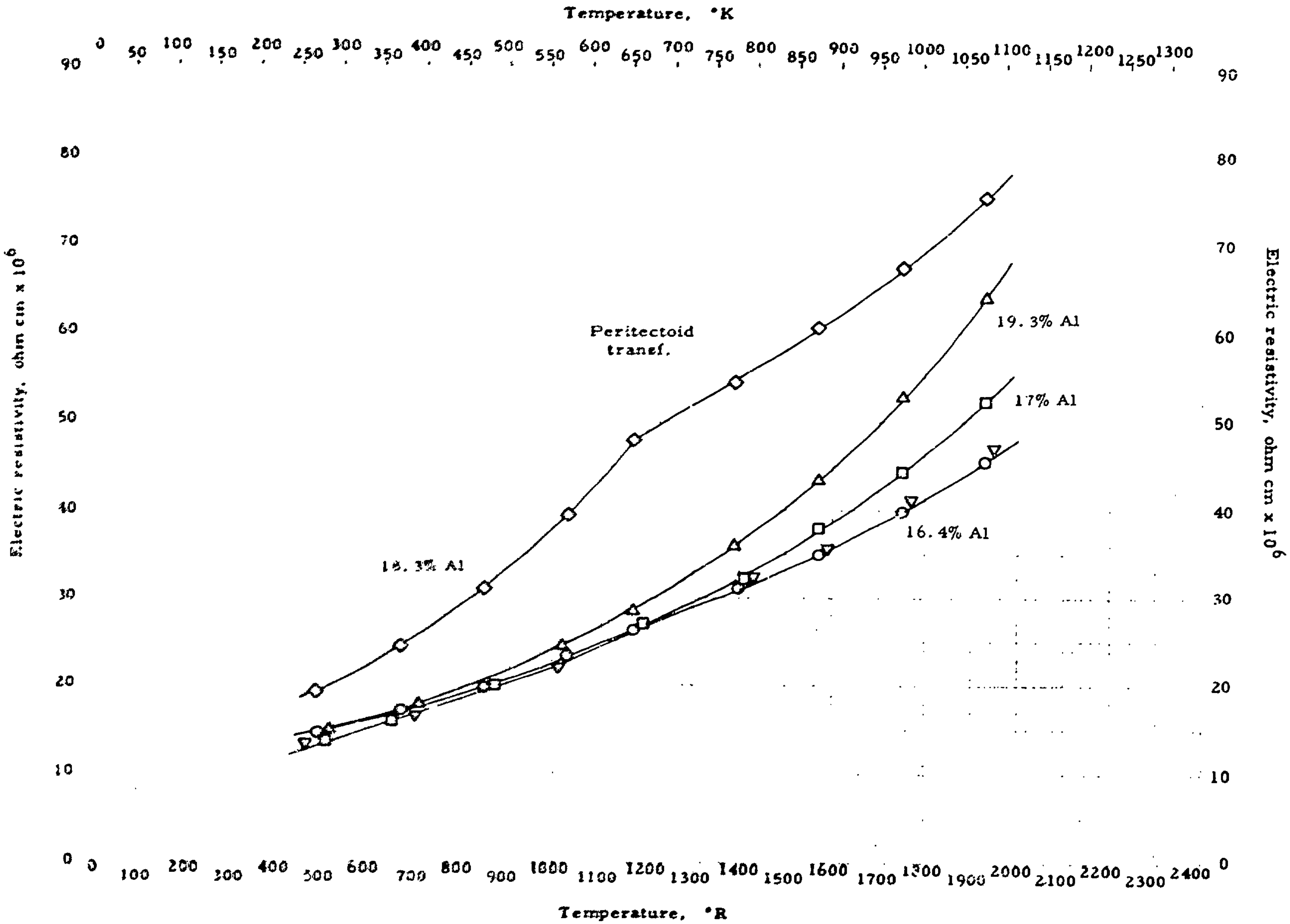
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., and Olson, O.H.	57-8	150-2260	Aluminum Bronze, Fed Spec. QQ-B-667, Composition 5. Nominal: 88-92.5% Cu, 6-8% Al; < 3.5% Fe, < 1% Mn	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolemeter, sample and receiver in vacuum	Same values for 2 surface conditions: as received or detergent cleaned
□	Ibid.	57-8	150-2260	Same as above	Same as above	Polished
△	Ibid.	57-8	150-2260	Same as above	Same as above	Oxidized 30 min. at red heat in air
◇	Ibid.	57-8	1960-2260	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearring filament optical pyrometer, sample temp. by thermocouple	As received
▽	Ibid.	57-8	1960-2260	Same as above	Same as above	Detergent cleaned
○	Ibid.	57-8	1960-2260	Same as above	Same as above	Polished
▽	Ibid.	57-8	1960-2260	Same as above	Same as above	Oxidized 30 min. at red heat in air
◠	Ibid.	57-8	150-2260	Aluminum Bronze, Fed Spec. QQ-B-667, Composition 3. Nominal: 92-96% Cu, 4-7% Al, < 0.5% Fe	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Same values for surface as received and detergent cleaned
△	Ibid.	57-8	150-2260	Same as above	Same as above	Polished
□	Ibid.	57-8	150-2260	Same as above	Same as above	Oxidized 30 min. at red heat in air
◇	Ibid.	57-8	1960-2260	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearring filament optical pyrometer; sample temp. by thermocouple	As received
▷	Ibid.	57-8	1960-2260	Same as above	Same as above	Detergent cleaned
▷	Ibid.	57-8	1960-2260	Same as above	Same as above	Polished
◇	Ibid.	57-8	1960-2260	Same as above	Same as above	Oxidized 30 min. at red heat in air



LINEAR THERMAL EXPANSION -- COPPER + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bollenrath, F., and Bungardt, W.	43-7	528-1932	91.49% Cu (by diff.); 8.45% Al; 0.06% impurities	Dilatometer, Leitz type	Cast, heated 12 hr. at 950°C, cooled in 400 hr. to room temp.; tested at 1°C/min.
□	Ibid.	43-7	528-1752	87.98% Cu (by diff.); 11.96% Al; 0.06% impurities	Same as above	Same as above
△	Hidnert, P. and Krider, H. S.	47-7	528-1212	Te - Al Bronze. 88.13% Cu; 9.50% Al; 1.95% Fe; 0.42% Te	Telemicroscopes sighting on wires supporting sample	Extruded at approx. 1550°F and aged at room temp. 18 to 40 months. Plotted data show avg. (within 1%) for 2 samples; both heating and cooling
◇	Hidnert, P. and Dickson, G.	43-6	528-1932	Tempaloy 841. 89.67% Cu; 5.04% Al; 4.47% Ni; 0.82% Si	Same as above	Avg. for 4 samples: cast at 1200°C; cast at 1200°C and annealed; cast, annealed, and quenched; air cooled
▽	Hidnert, P.	43-12	528-1932	Al Bronze. 89.71% Cu; 9.29% Al; 0.44% Fe 0.38% Sn; 0.18% Ni	Telemicroscopes sighting on wires supporting sample	▽ - heating ▽ - cooling
▽	Ibid.	43-12	528-1932	Al Bronze. 89.43% Cu; 9.30% Al; 0.58% Fe; 0.36% Ni; 0.33% Sn	Same as above	▽ - heating; ▽ - cooling
○	Ibid.	43-12	528-673	Al Bronze. 90% Cu; 10% Al	Same as above	
◻	Perry, S.	45-6	360-528	Al Bronze. 90.31% Cu; 7.64% Al; 2.05% Si	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
◻	Le Roux, R.	53-128	528-1752	11.95% Al	Chevenard differential dilatometer with pyros standard	Heating rate 4°C/min. Cooling rate 0.3°C/min. ◻ - heating ◻ - cooling

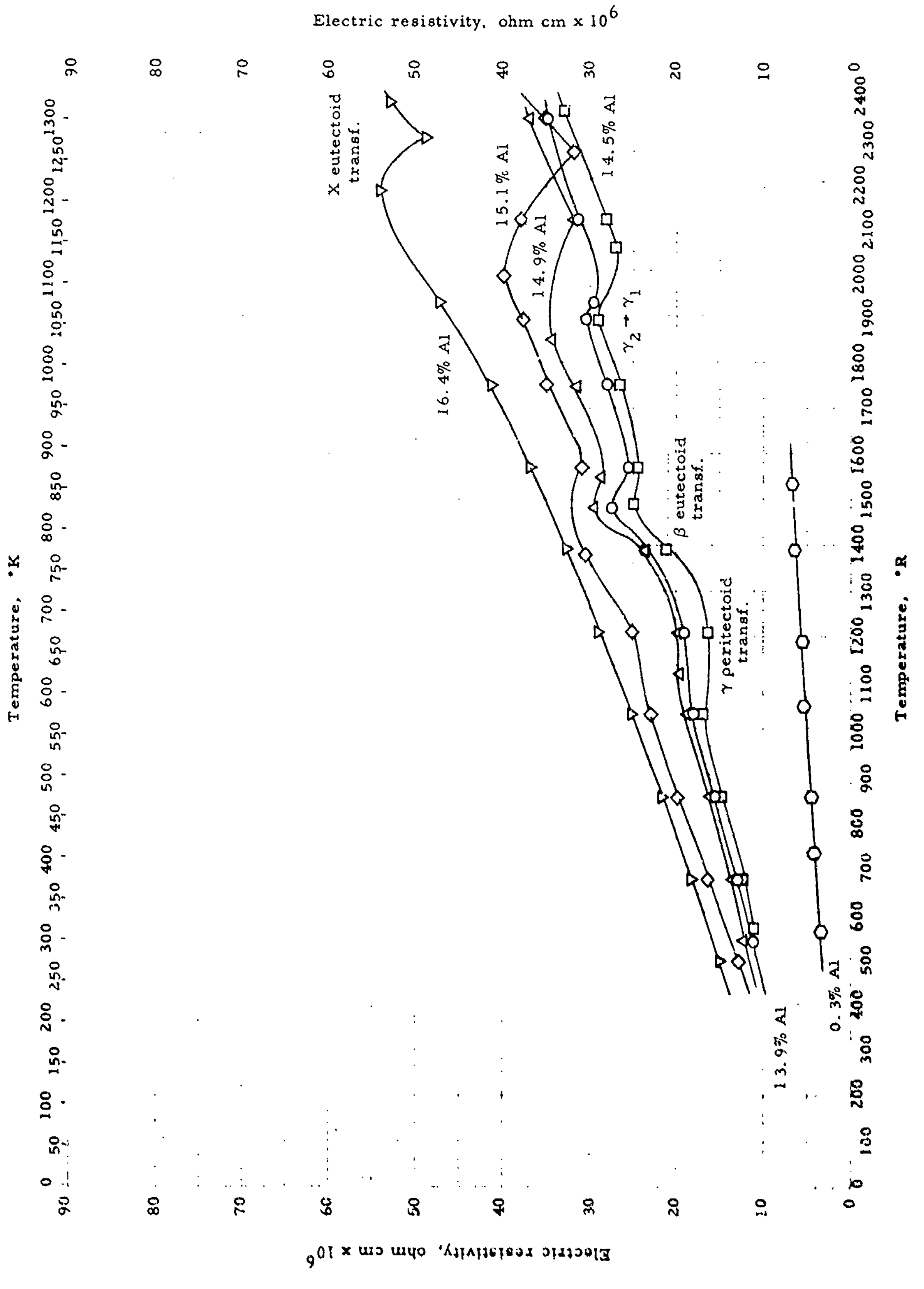


ELECTRIC RESISTIVITY -- COPPER + ALUMINUM (γ_2 PHASE)

ELECTRIC RESISTIVITY -- COPPER + ALUMINUM (γ_2 PHASE)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pecijare, O. and [illegible], S.	57-107	492-1932	16.41% Al	Not given	γ_2 phase
□	Ibid.	57-107	492-1932	17.05% Al	Same as above	Same as above
▽	Ibid.	57-107	492-1932	17.40% Al	Same as above	Same as above
◇	Ibid.	57-107	492-1932	18.30% Al	Same as above	Same as above
△	Ibid.	57-107	492-1932	14.30% Al	Same as above	Same as above

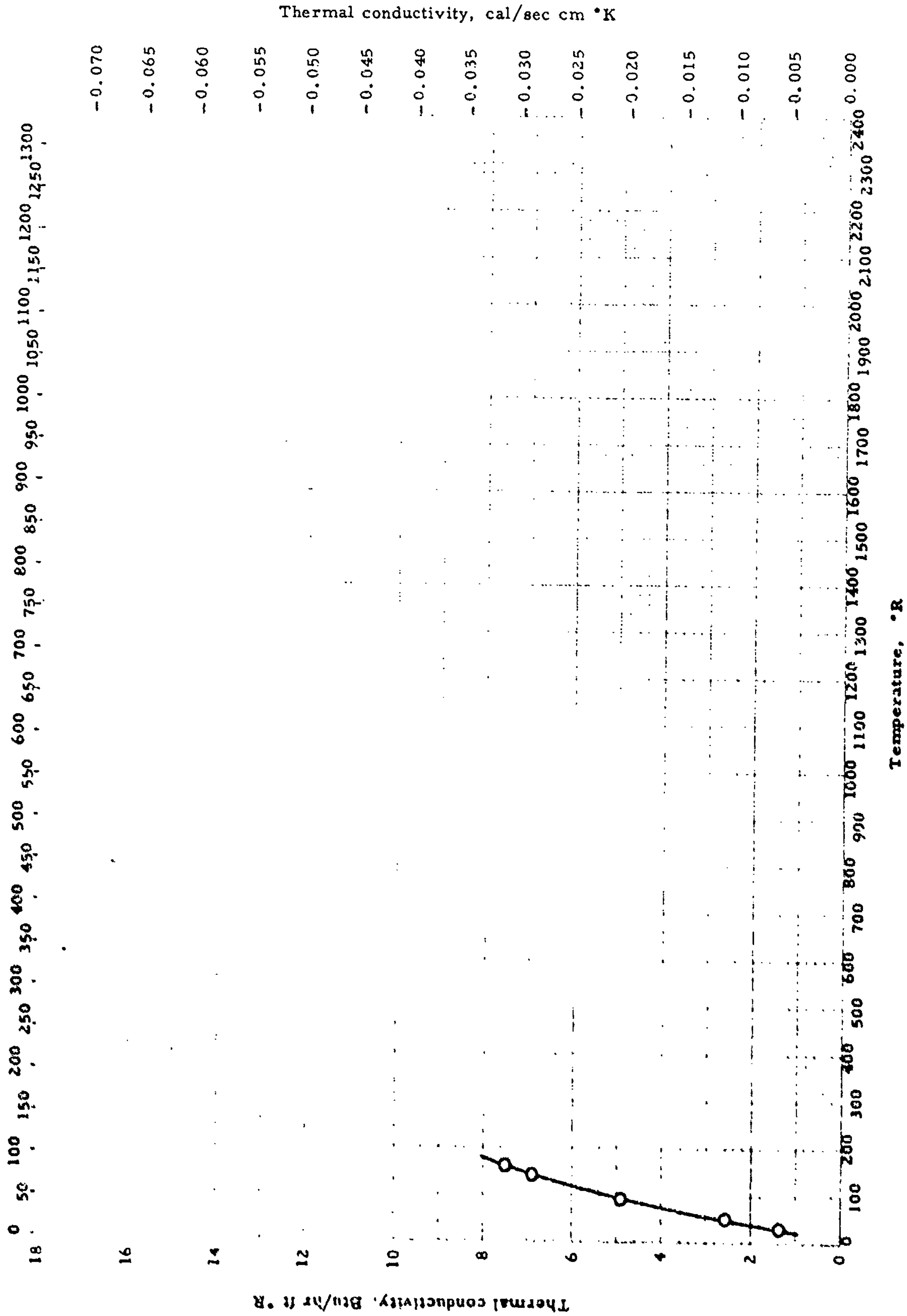


ELECTRIC RESISTIVITY -- COPPER + ALUMINUM

ELECTRIC RESISTIVITY -- COPPER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Janssen, S., and Pacijare, O.	57-66	537-2328	13.9% Al	Not given	
□	Ibid.	57-66	564-2346	14.5% Al	Same as above	
△	Ibid.	57-66	537-2328	14.9% Al	Same as above	
◇	Ibid.	57-66	492-2328	15.15% Al	Same as above	
▽	Ibid.	57-66	492-2364	16.4% Al	Same as above	
○	Mikryukov, V. E.	56-71	564-1535	0.3% Al; 0.27% Zr	Potential drop	Normalized

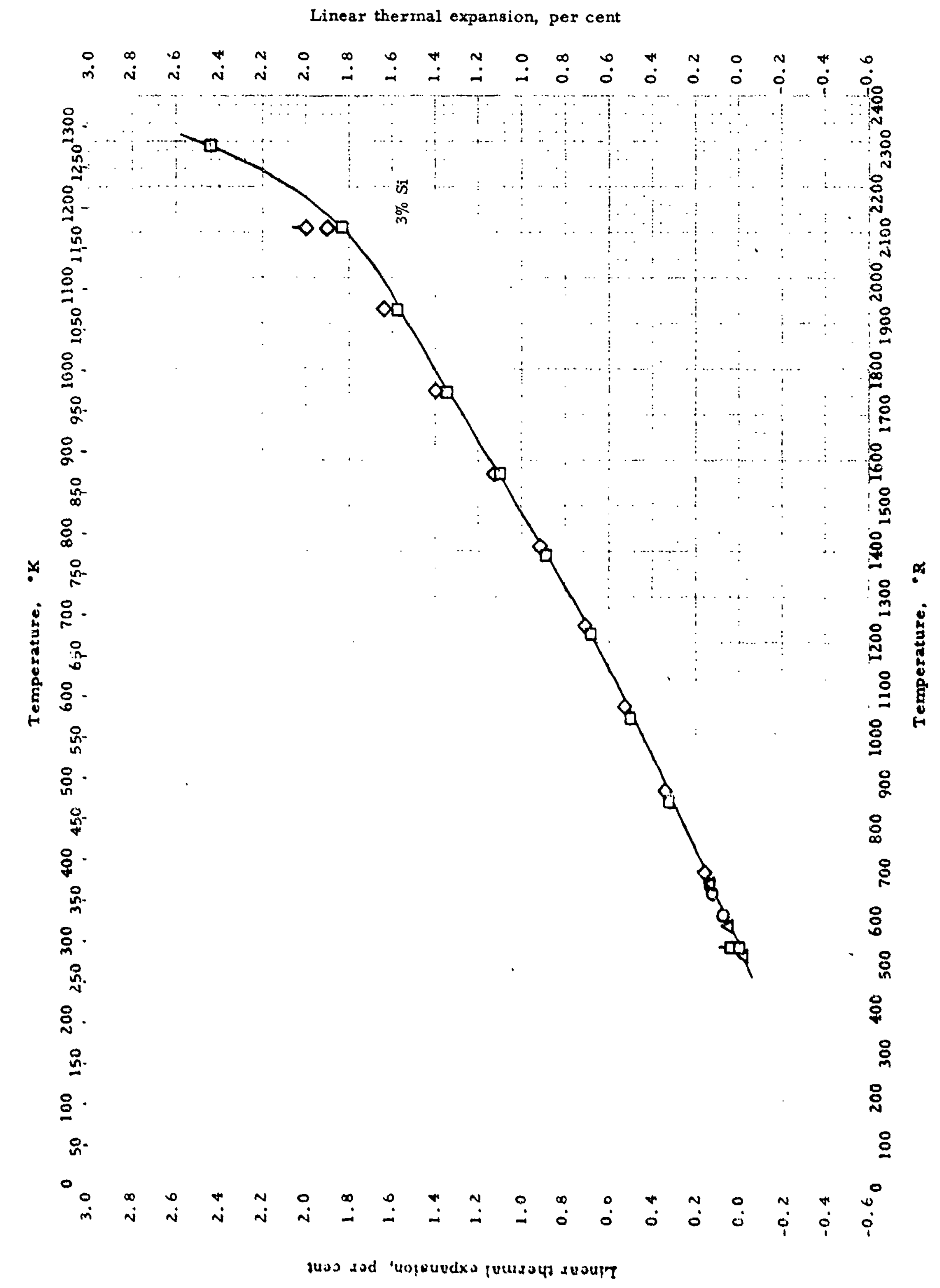


THERMAL CONDUCTIVITY -- COPPER + SILICON + X

THERMAL CONDUCTIVITY -- COPPER + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Powell, R. L., Roder, H. M., and Rogers, W. M.	57-37	27-162	Silicon bronze: 3.15% Si; 1.13% Mn; 1% Zn; 0.001% ea. Cd, Cr, Fe, Ag; < 0.001% ea. Al, B, Ca, Pd, Sn	Axial heat flow in rod; guarded heat source and sample	Tested in vacuum ($<10^{-6}$ mm Hg)

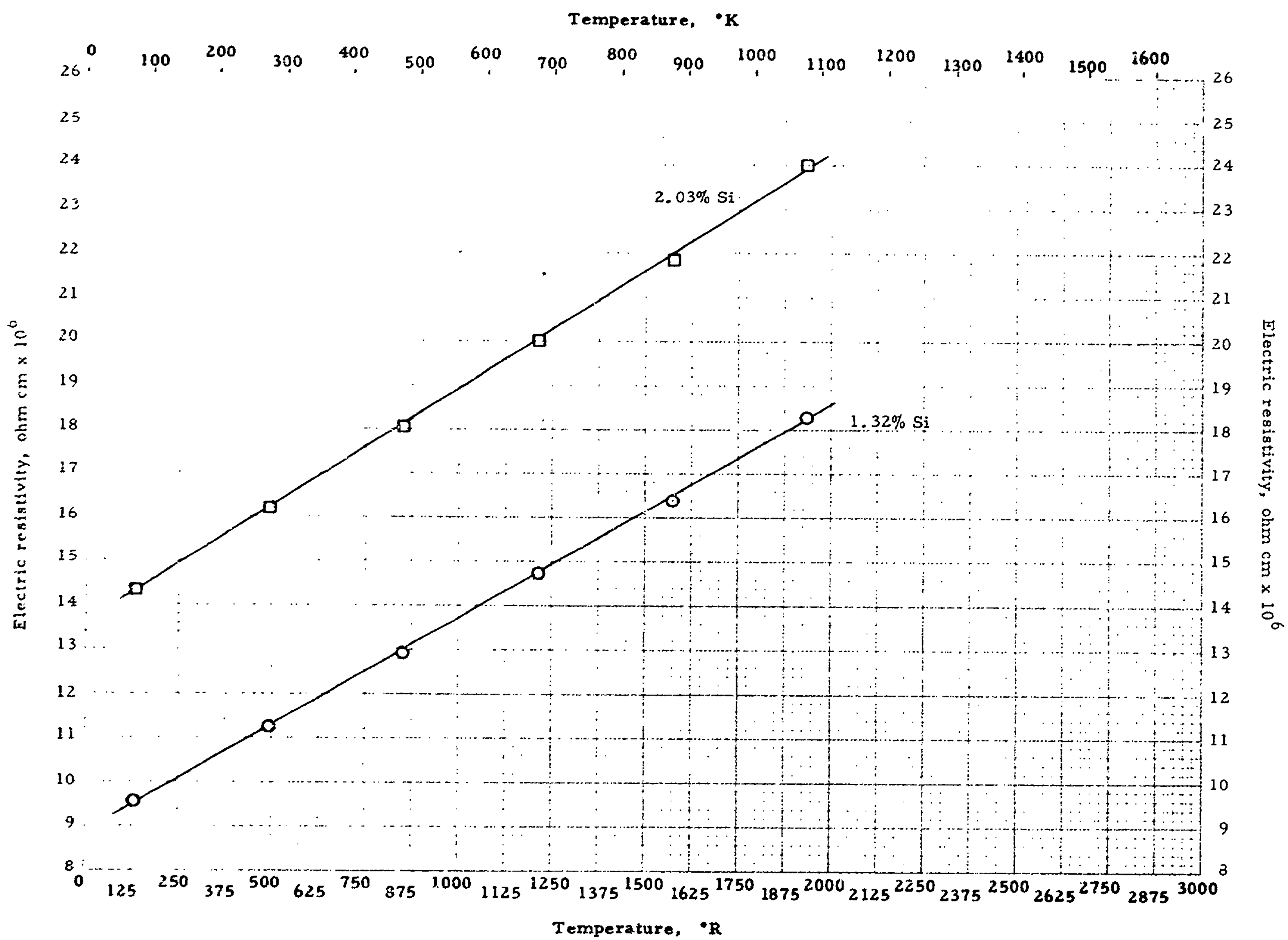


LINEAR THERMAL EXPANSION -- COPPER + SILICON + X

LINEAR THERMAL EXPANSION -- COPPER + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P., and Krider, H. S.	47-7	528-1032	Si Bronze, Type B: 97.39% Cu; 1.41% Zn; 0.04% Ni; 0.02% Fe; < 0.01% Pb.	Telemicroscopes sighting on wires supporting sample	Annealed at 1200° F
□ ⍓	Hidnert, P.	43-12	558-2292	Silicon Bronze: 95.64% Cu; 3.04% Si; 1.03% Mn; 0.09% Fe	Telemicroscopes	2 samples: Hard drawn, and annealed. Max. deviation 2% ⍓ : cooling
△	Ibid.	43-12	528-672	Silicon Bronze: 94.6% Cu; 4.0% Si; 1.1% Mn; 0.15% Fe; 0.06% P	Same as above	
◇ ◇̍	Ibid.	43-12	528-2112	Silicon Bronze: 94.33% Cu; 4.40% Si; 0.96% Mn; 0.11% Fe	Same as above	◇̍ : cooling. Below 2000° R, heating and cooling curves are graphically identical

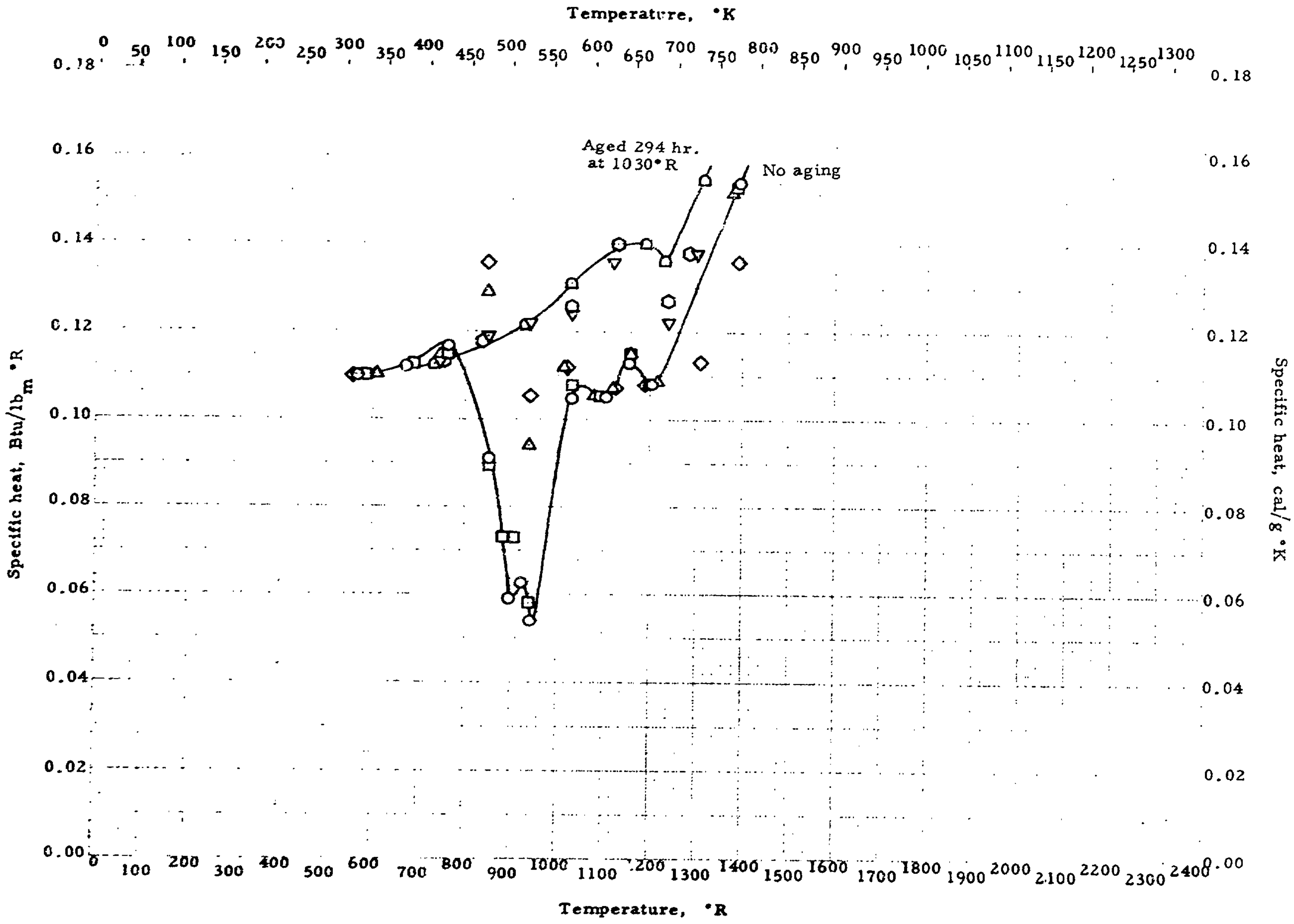


ELECTRIC RESISTIVITY -- COPPER + SILICON + X

ELECTRIC RESISTIVITY -- COPPER + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Domenicalli, C. A.	53-27 also 55-7	132-1932	1.32% Si; prepared from 99.99% pure Cu and 99.97% pure Si (possibly 0.2% O_2)	Potential drop	Melted in graphite crucibles under vacuum, homogenized 18 hr. just below M.P.
□	Ibid.	53-27 also 55-7	132-1932	2.03% Si; raw materials same as above	Same as above	Same as above

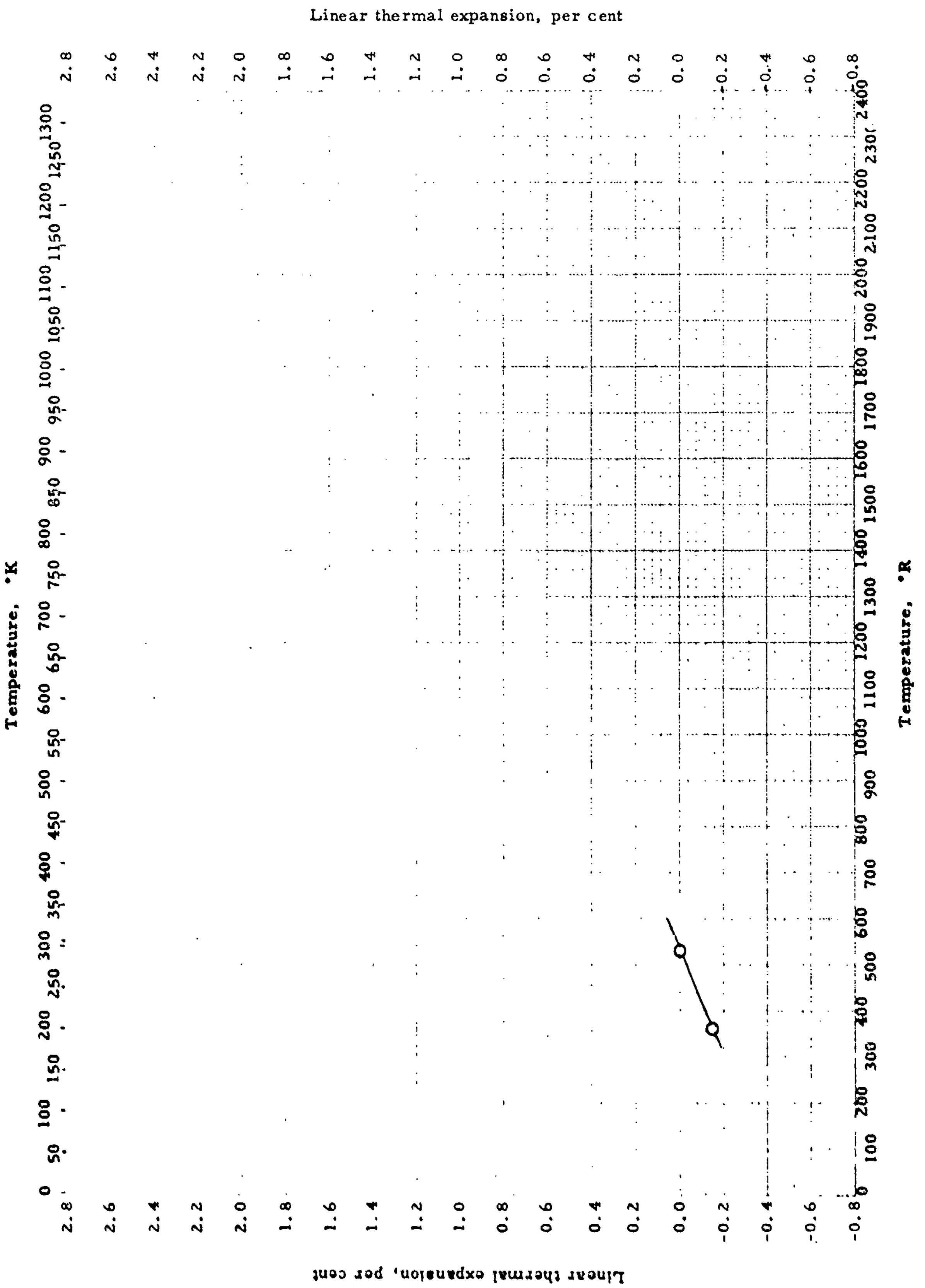


SPECIFIC HEAT -- COPPER + BERYLLIUM

SPECIFIC HEAT -- COPPER + BERYLLIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hirano, K.	55-45	672-1572	1.8% Be	Nagasaki-Takagi calorimeter	Heated 4 hr. at 800°C and quenched. Not aged
□	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 13 hr. at 130°C
△	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 90 hr. at 130°C
◇	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 760 hr. at 130°C
▽	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 1 hr. at 300°C
○	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 45 hr. at 300°C
◠	Ibid.	55-45	672-1572	Same as above	Same as above	Heated and quenched as above; then aged 294 hr. at 300°C

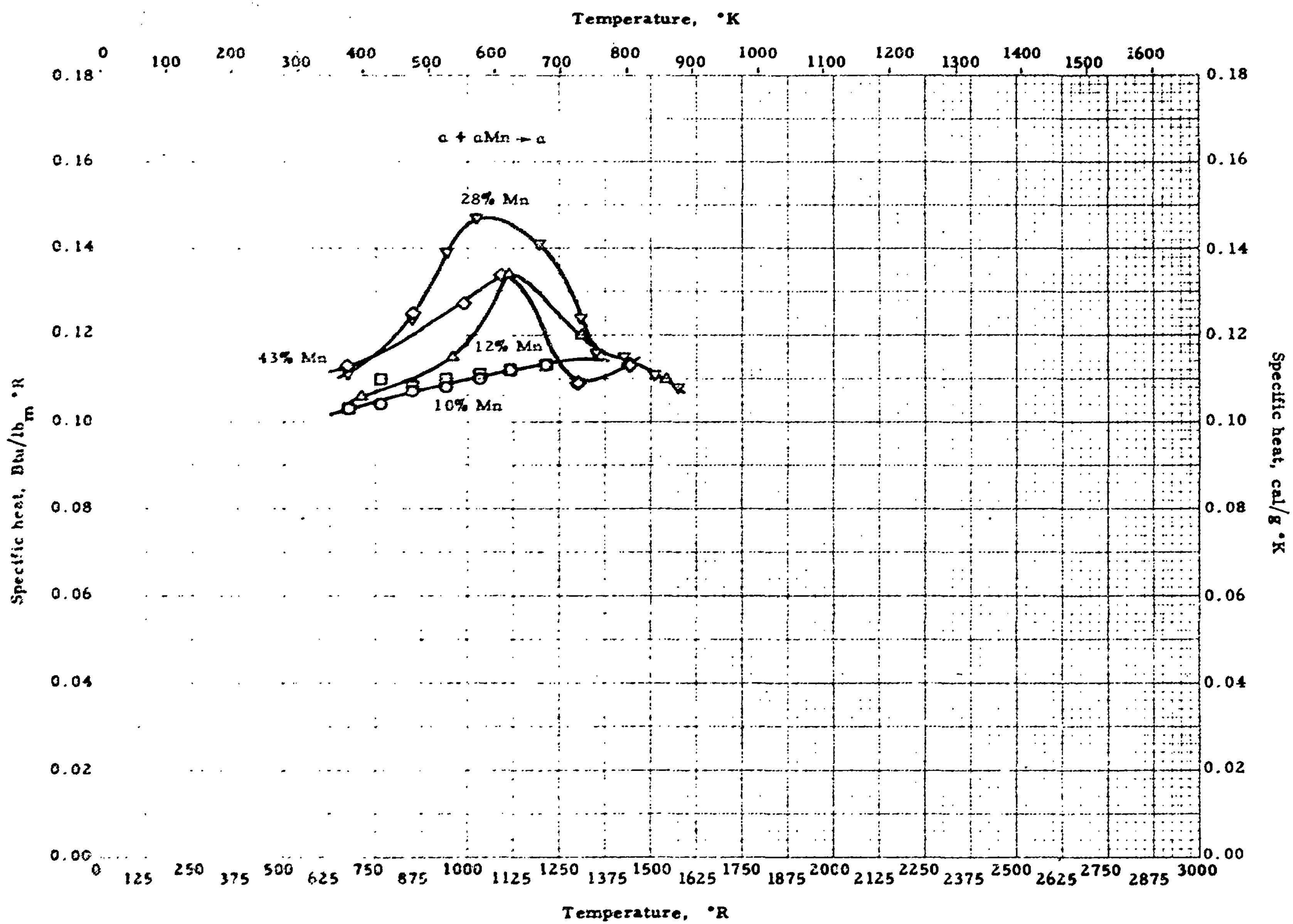


LINEAR THERMAL EXPANSION -- COPPER + BERYLLIUM + X

LINEAR THERMAL EXPANSION -- COPPER + BERYLLIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Perry, S.	45-6	360-528	Be Copper No. 175: 97.5% Cu; 2.15% Be; 0.35% Ni	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%

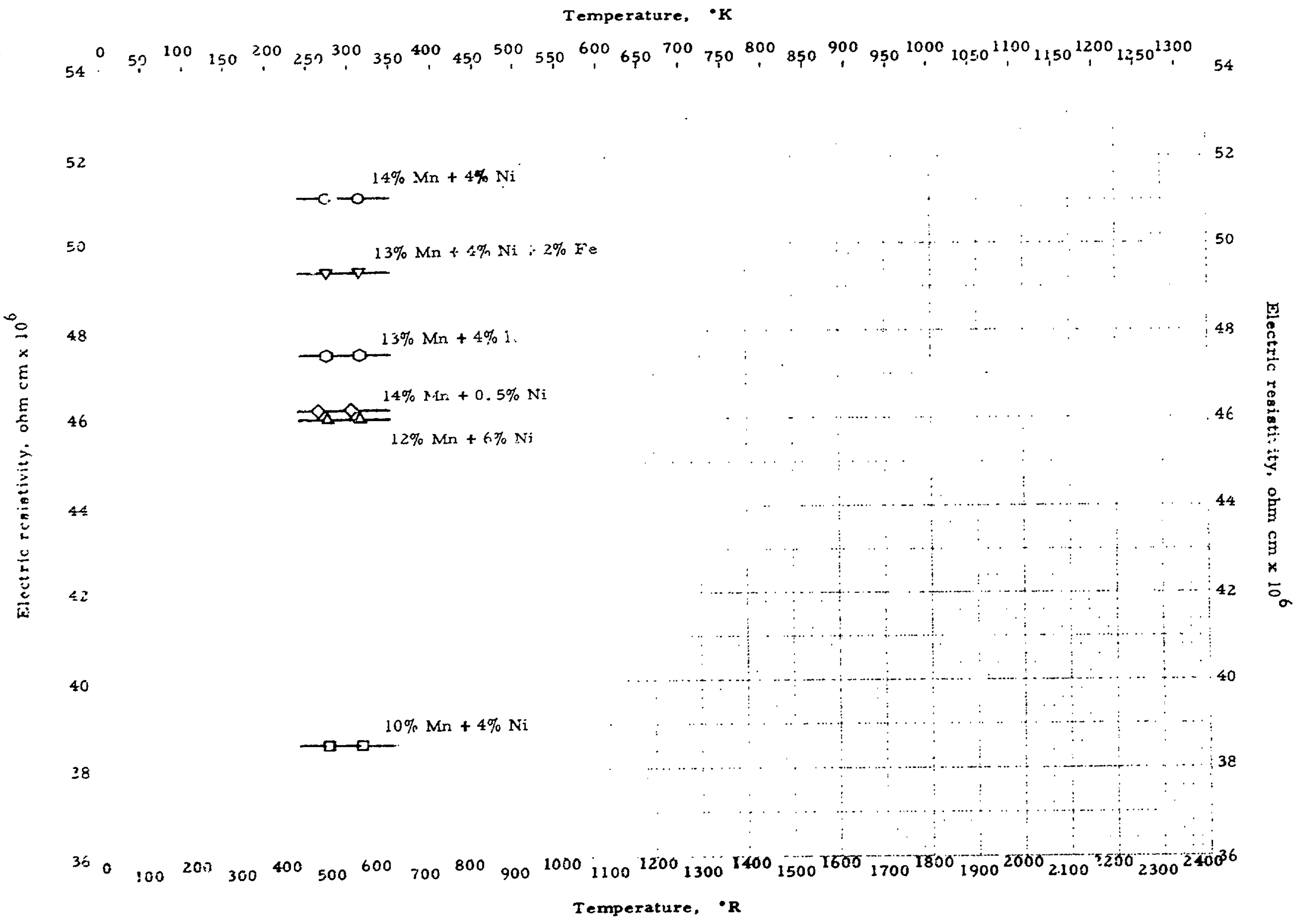


SPECIFIC HEAT -- COPPER + MANGANESE

SPECIFIC HEAT -- COPPER + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hirano, K., Maniwa, H. and Takagi, Y.	55-23	672-1232	90% Cu; 10% Mn	Not given; data indicates a direct method	Quenched from 800°C; annealed 2000 hr. at 130°C
□	Ibid.	55-24	672-1232	Same as above	Same as above	Cooled from 600°C at 3°C/min.
△	Kawasaki, M., Yamaji, K. and Izumi, O.	55-127	672-1572	12.5% Mn	Not described here, refers to others	Melted, hot forged, homogenized 7 days at 800°C in CO_2 atm. Cooled 14 days at 200°C in furnace.
▽	Ibid.	55-127	672-1572	28.3% Mn	Same as above	Same as above
◇	Ibid.	55-127	672-1572	43.1% Mn	Same as above	Same as above

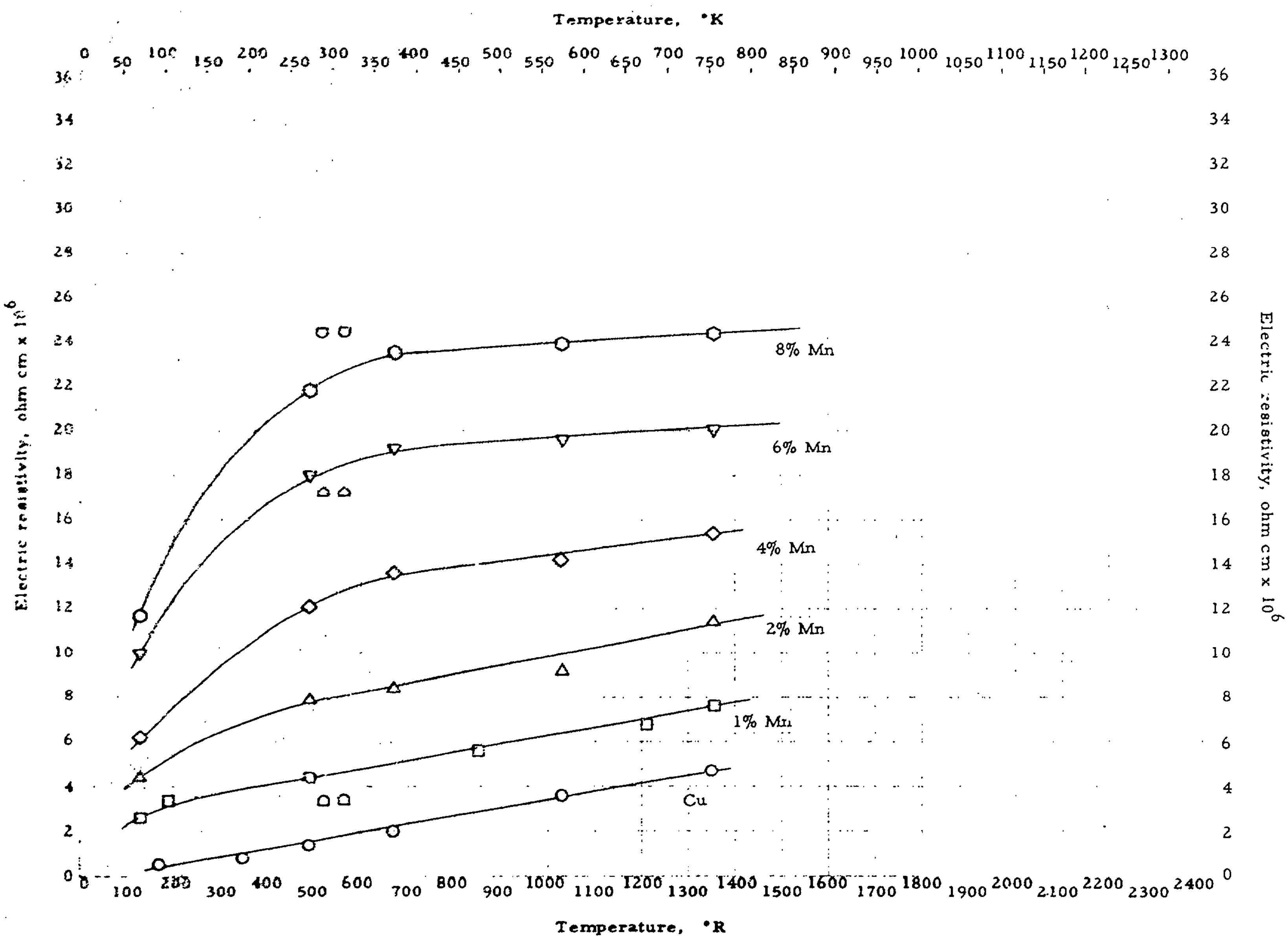


ELECTRIC RESISTIVITY -- COPPER + MANGANESE + NICKEL + X

ELECTRIC RESISTIVITY -- COPPER + MANGANESE + NICKEL + X

REFERENCE INFORMATION

Sym-bol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
◻	Pollock, D.D. and Finch, D.I.	56-114	492-564	Manganin type alloy: 9.86% Mn; 4.35% Ni; 0.083% Fe; <0.008% Mg; <0.04% Si; <0.001% ea. of others	Kelvin double bridge	Cast, pickled, cold rolled, annealed 1 hr. at 790 °C in NH_3 atm., slowly cooled to room temp., cold drawn annealed 1 hr. at 570 °C in NH_3 atm., reannealed, etched
△	Ibid.	56-114	492-564	11.63% Mn; 6.03% Ni; 0.019% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
○	Ibid.	56-114	492-564	12.75% Mn; 4.25% Ni; 0.002% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
▽	Ibid.	56-114	492-564	12.87% Mn; 4.27% Ni; 2.03% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
◇	Ibid.	56-114	492-564	13.54% Mn; 0.504% Ni; 0.231% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above
○	Ibid.	56-114	492-564	14.13% Mn; 4.26% Ni; 0.281% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. of others	Same as above	Same as above. Auth. gives additional data for 35 other alloys



ELECTRIC RESISTIVITY -- COPPER + MANGANESE

ELECTRIC RESISTIVITY -- COPPER + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F. A.	56-46	132-1392	99.99% pure Cu	Potential drop	Heated 24 hr. at 900°C, swaged, annealed 1 hr. at 500°C
□	Ibid.	56-46	132-1392	1% Mn; prepared from 99.99% pure raw material	Same as above	Vacuum melted 100°C above melting point, homogenized 24 hr. at 900°C, swaged, annealed 1 hr. at 500°C
△	Ibid.	56-46	132-1392	2% Mn; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-46	132-1392	4% Mn; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-46	132-1392	6% Mn; raw materials same as above	Same as above	Same as above
○	Ibid.	56-46	132-1392	8% Mn; raw materials same as above	Same as above	Same as above
◻	Pollock, D. D. and Finch, D. I.	56-114	519-564	0.553% Mn; <0.004% Si; <0.008% Mg; <0.001% ea. of others	Kelvin double bridge	Auth. report relative resistance values for many alloys in the system Cu + Mn + Ni + Fe
△	Ibid.	56-114	519-564	5.27% Mn; <0.004% Si; <0.008% Mg; <0.001% ea. of others	Same as above	
○	Ibid.	56-114	519-564	7.44% Mn; <0.004% Si; <0.008% Mg; <0.001% ea. of others	Same as above	

PROPERTIES OF COPPER + TELLURIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 0.56% Te . . .	560 lb_m/ft^3	8.9 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

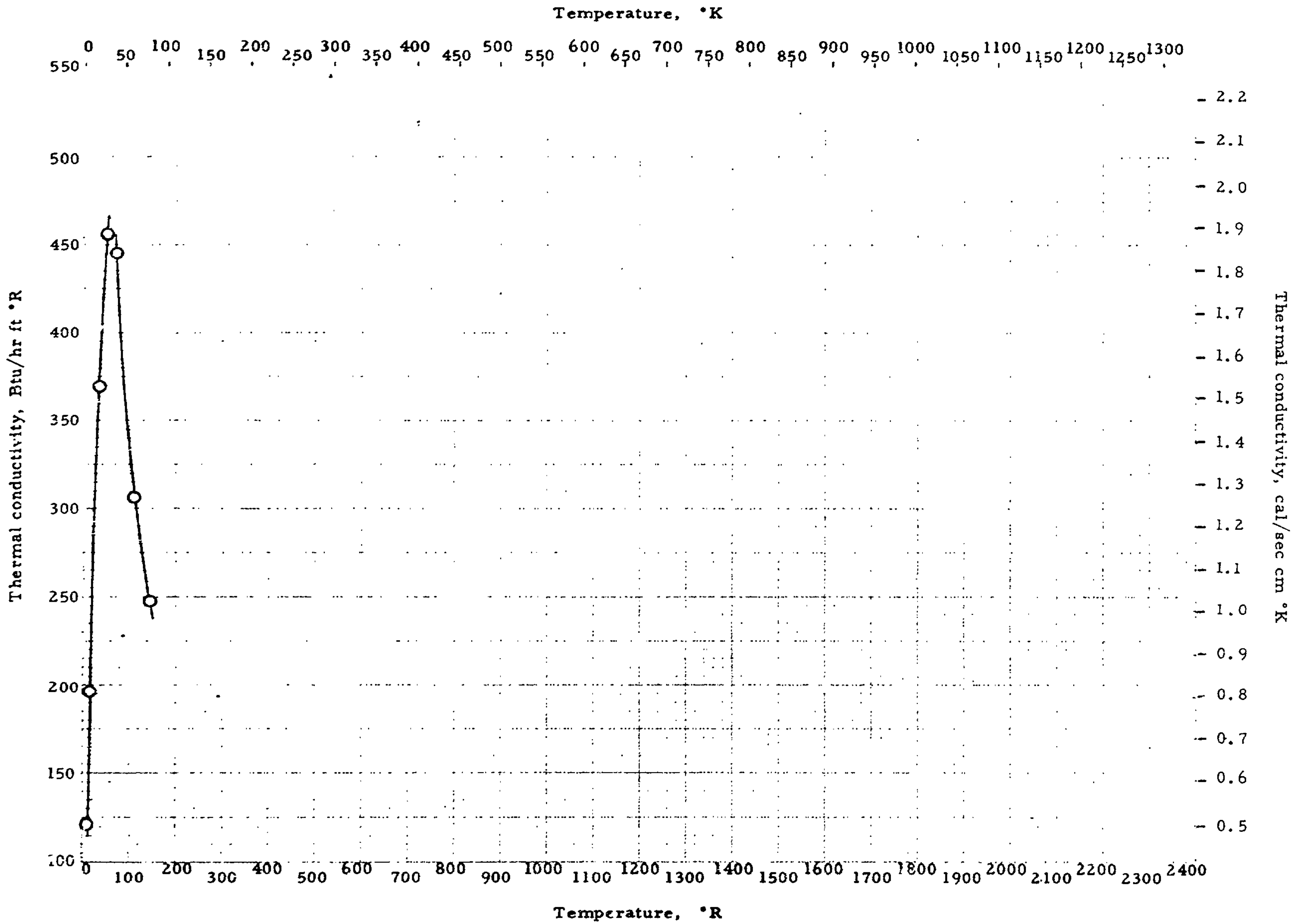
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	560	8.9
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF COPPER + TELLURIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L., Roder, H. M. and Rogers, W. M.	57-37	Room	0.56% Te; 0.007% P; 0.001% ea. Fe, Si, Ag, Zn; <0.001% ea. Al, Pb, Mg, Mn, Sn	ρ: not given	

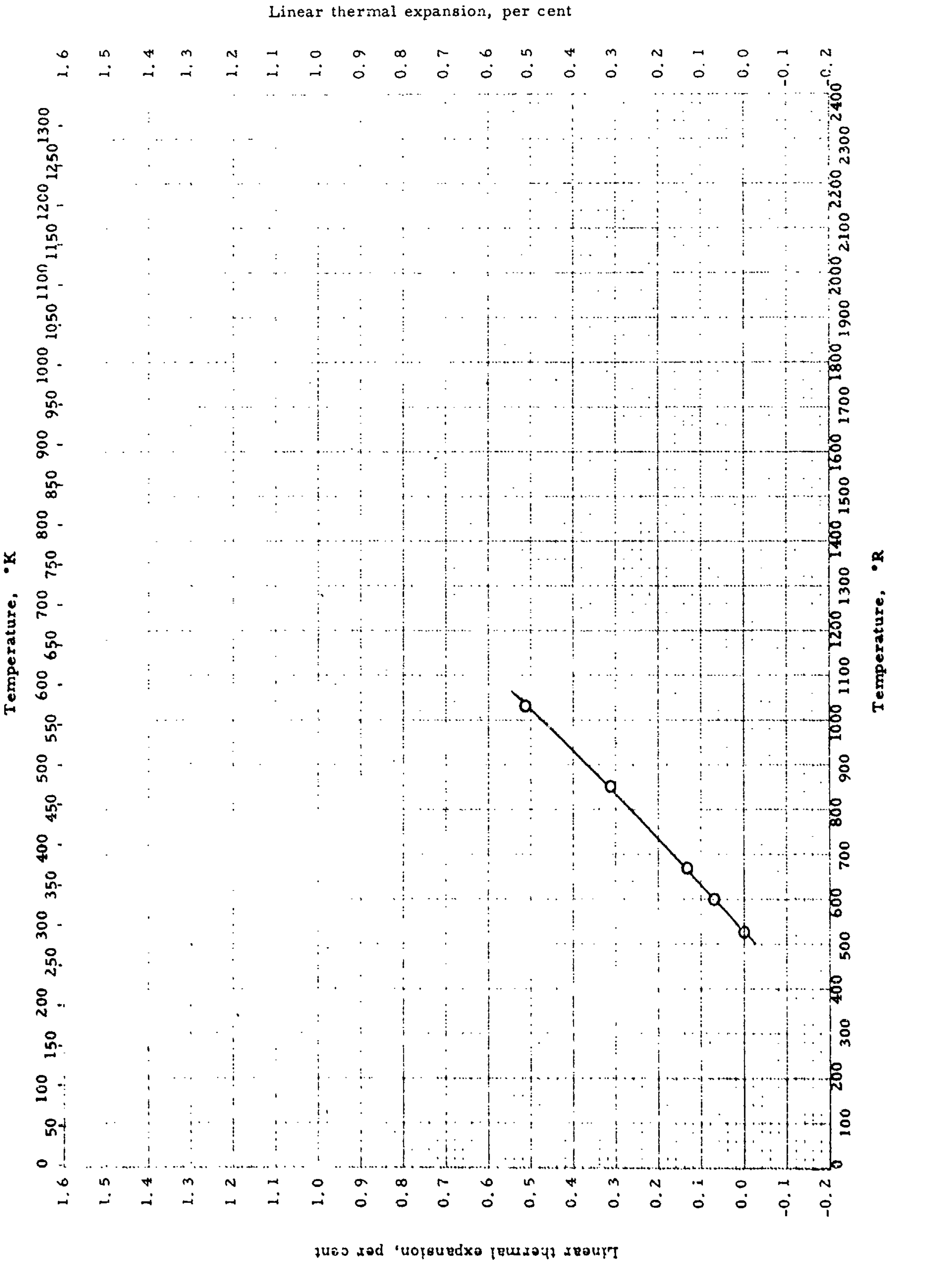


THERMAL CONDUCTIVITY -- COPPER + TELLURIUM

THERMAL CONDUCTIVITY -- COPPER + TELLURIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L., Roder, H M. and Rogers, W. M.	57-37	10-144	Free cutting tellurium copper: 0.56% Te; 0.007% P; 0.001% ea. Fe, Si, Ag, Zn; < 0.001% ea. Al, Pb, Mg, Mn, Sn. $\rho = 555\ lb_m/ft^3$; average grain size 0.1 x 0.016 x 0.016 mm	Axial heat flow in rod; guarded heat source and sample	Tested in vacuum ($<10^{-6}$ mm Hg)

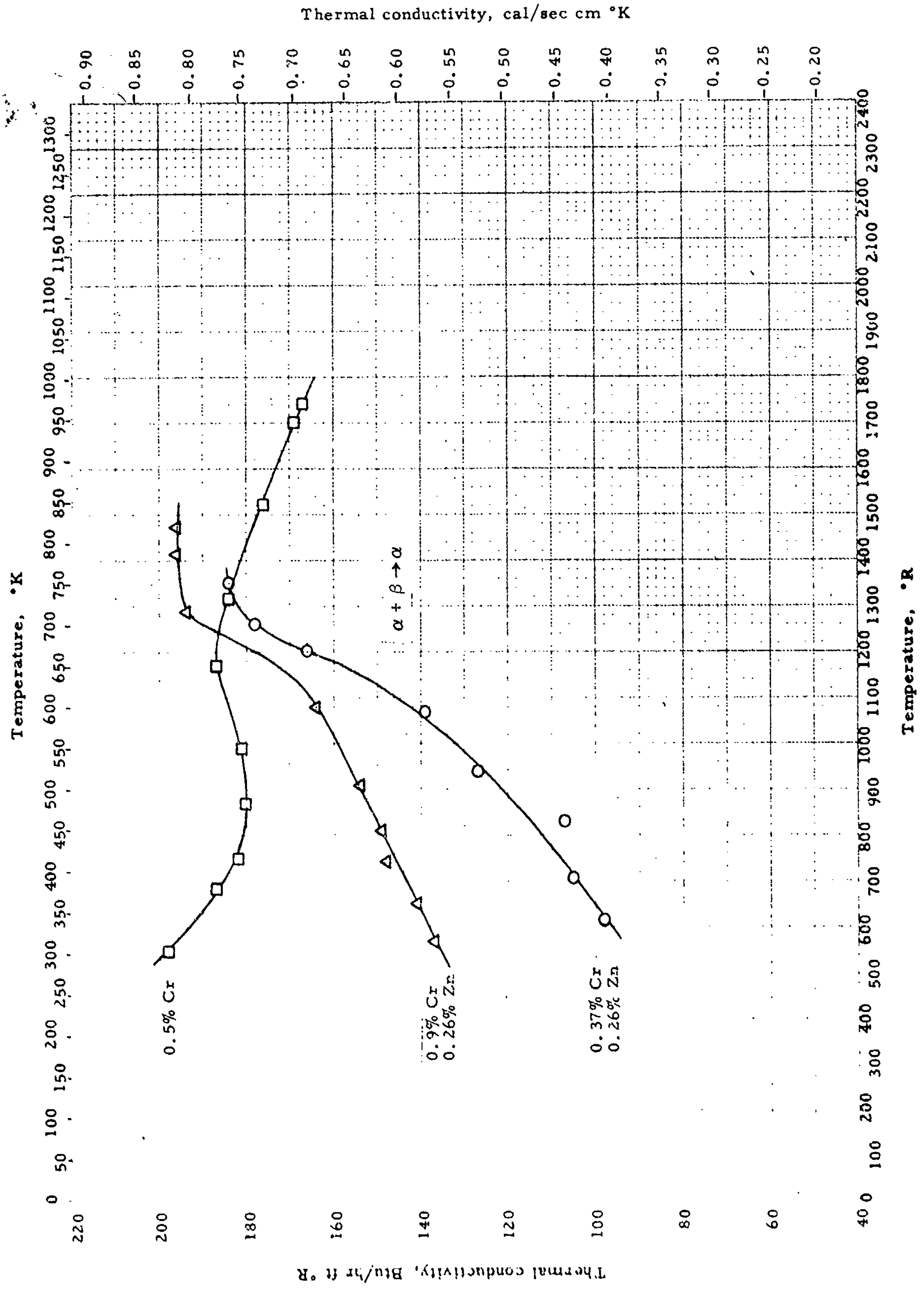


LINEAR THERMAL EXPANSION -- COPPER + TELLURIUM + X

LINEAR THERMAL EXPANSION -- COPPER + TELLURIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hidnert, P. and Krider, H. S.	47-7	528-1032	Te copper: 99.27% Cu; 0.65% Te; 0.06% Zn; 0.01% Ni; 0.003% ea. Fe, Pb	Telemicroscopes sighting on wires suspending sample	Cold drawn and annealed at 1100°F

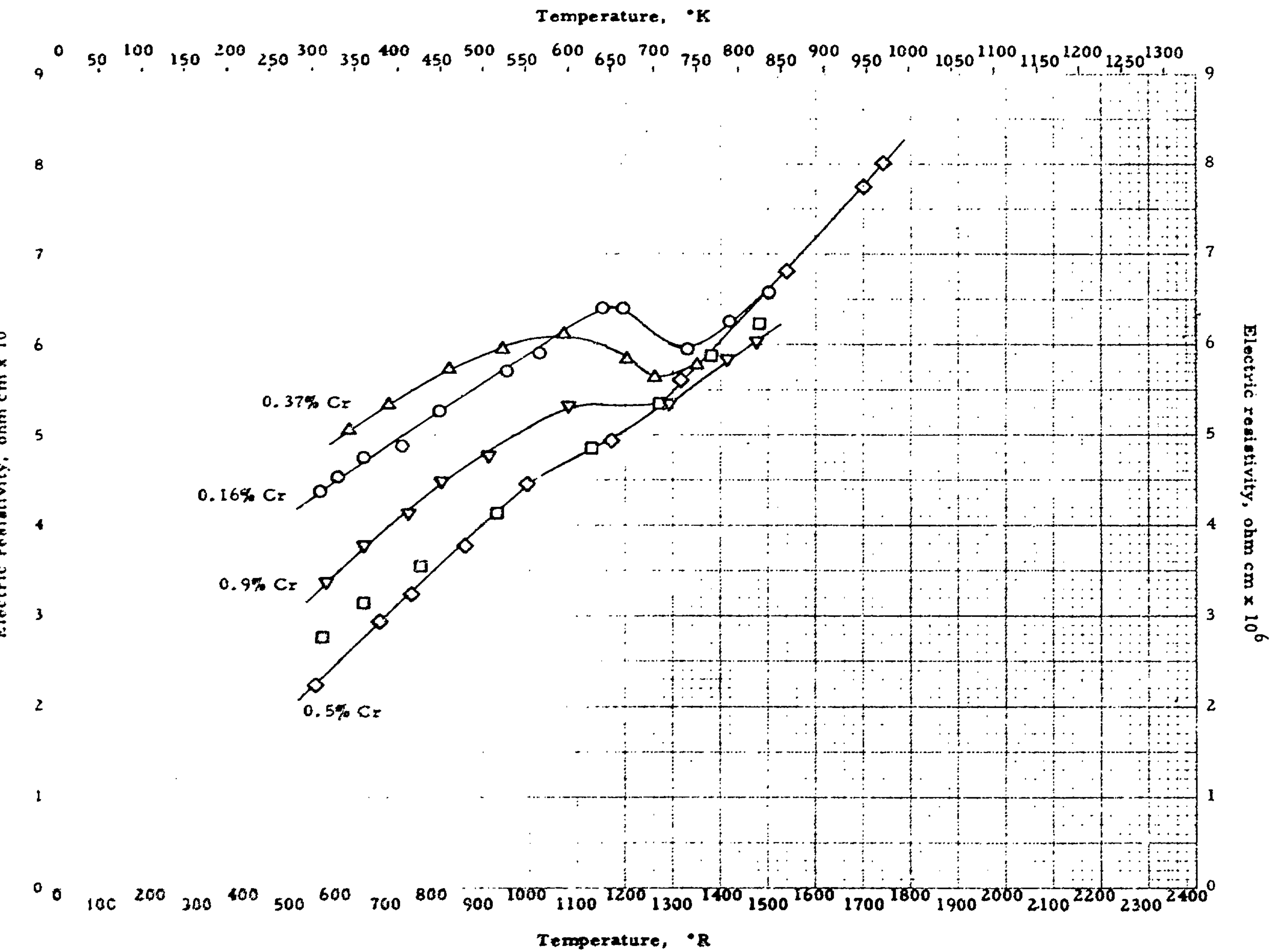


THERMAL CONDUCTIVITY -- COPPER + CHROMIUM + X

THERMAL CONDUCTIVITY -- COPPER + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V.E.	56-71	617-1352	0.37% Cr; 0.25 - 0.28% Zr	Temp. distribution along resistance heated rod	Normalized
□	Ibid.	56-71	551-1741	0.5% Cr	Same as above	Same as above
△	Ibid.	56-71	569-1477	0.9% Cr; 0.25 - 0.28% Zr	Same as above	Same as above



ELECTRIC RESISTIVITY -- COPPER + CHROMIUM + X

ELECTRIC RESISTIVITY -- COPPER + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Mikryakov, V. E.	56-71	[illegible]	0.16% Cr, 0.2% Zr, 0.1 - 0.2% Ti, 0.2% Ni	Potential drop	Normalized
□	Ibid.	56-71	[illegible]	Same as above	Same as above	Quenched, tempered
△	Ibid.	56-71	[illegible]	0.37% Cr, 0.25 - 0.28% Zr	Same as above	Normalized
◇	Ibid.	56-71	[illegible]	0.5% Cr	Same as above	Same as above
▽	Ibid.	56-71	[illegible]	0.5% Cr, 0.25 - 0.28% Zr	Same as above	Same as above

PROPERTIES OF COPPER + ZIRCONIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 1% Zr	550 lb_m/ft^3	8.8 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

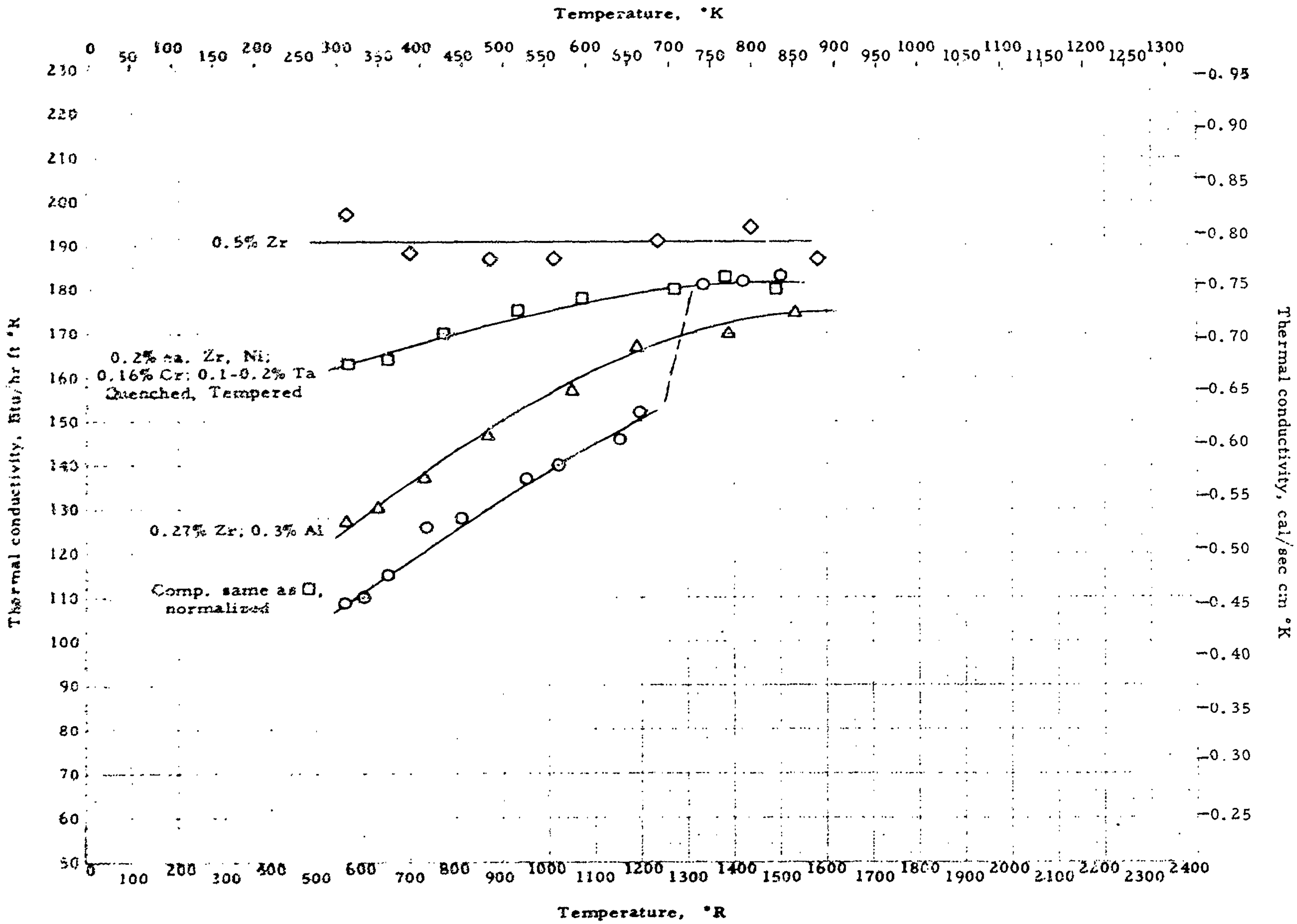
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	550	8.8
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF COPPER + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Dies, K.	57-147	Room	0.8% Zr	ρ : not given	Vacuum melted cast from electrolytic Cu and pure Zr sponge, pressed at 750°C, annealed 2 hr. at 650°C, furnace cooled, annealed, water quenched

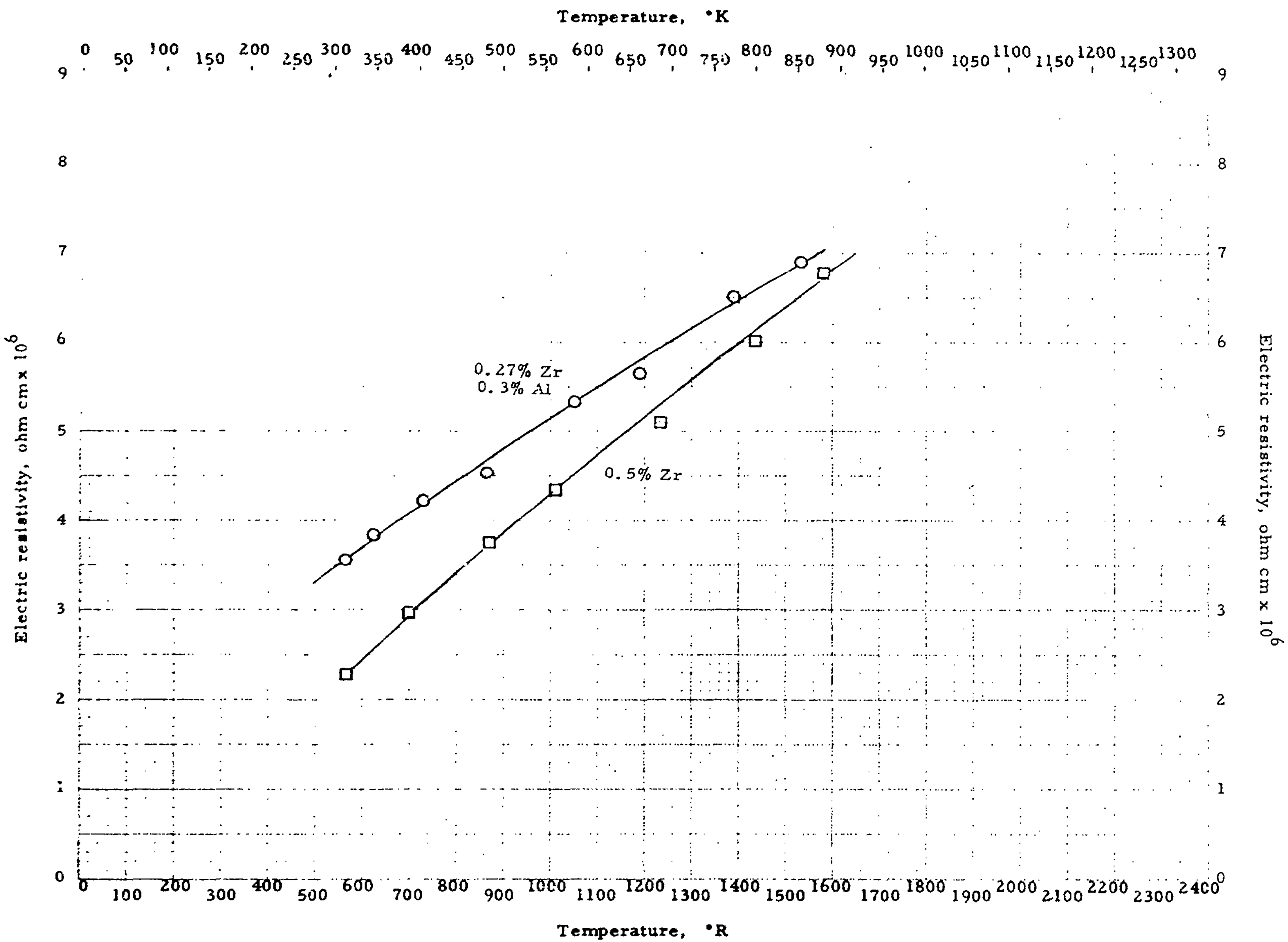


THERMAL CONDUCTIVITY -- COPPER + ZIRCONIUM + X

THERMAL CONDUCTIVITY -- COPPER + ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E.	56-71	560-1503	0.2% Zr; 0.2% Ni; 0.16% Cr; 0.1-0.2% Ta	Temperature distribution along resistance heated rod	Normalized
□	Ibid.	56-71	560-1503	Same as above	Same as above	Tempered after quenching
△	Ibid.	56-71	564-1535	0.27% Zr; 0.3% Al	Same as above	Normalized
◇	Ibid.	56-71	564-1582	0.5% Zr	Same as above	Same as above

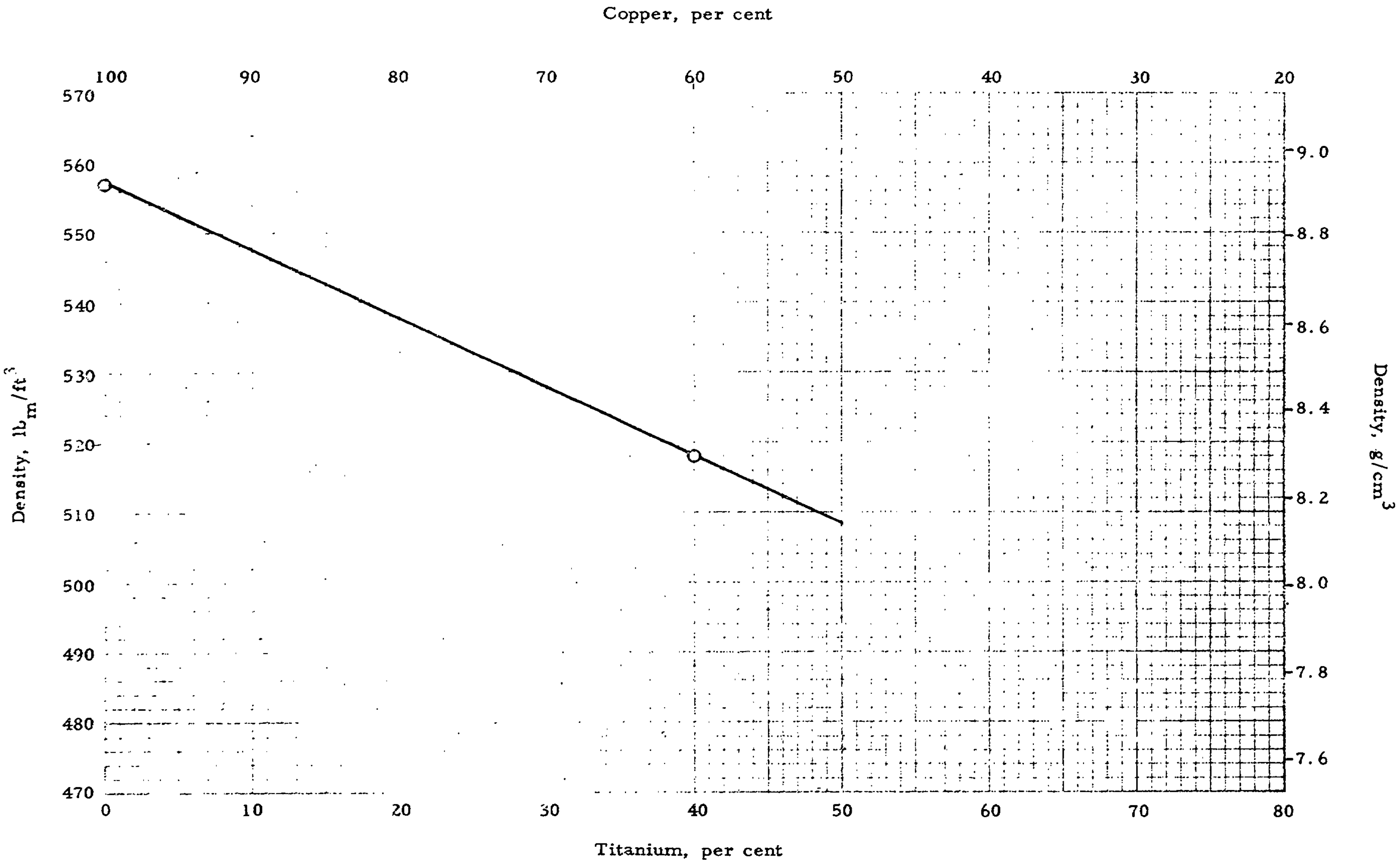


ELECTRIC RESISTIVITY -- COPPER + ZIRCONIUM + X

THERMAL RESISTIVITY -- COPPER + ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E.	56-71	565-1535	0.27% Zr; 0.3% Al	Potential drop	Normalized
□	Ibid.	56-71	564-1582	0.5% Zr	Same as above	Same as above



DENSITY -- COPPER + TITANIUM

DENSITY -- COPPER + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Dies, K.	57-147	Room	0 - 40% Titanium	Not given	Vacuum melted and cast from electrolytic Cu and sponge Ti of high purity, turned, pressed, annealed at 650° C, furnace cooled at 36° C/hr

Symbol	Nominal Composition, %			Melting Point	
	Cu	Co	Pd	°R	°K
O	70	20	10	2413	1340
	60	30	10	2441	1356
	50	30	20	2513	1396
	40	40	20	2548	1415
	40	30	30	2526	1403

MELTING POINT -- COPPER + COBALT + PALLADIUM

MELTING POINT -- COPPER + COBALT + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigorev, A. T., Panteleimonov, L. A., et al.	56-31	2413-2548	Ternary system; 40-70% Cu; 20-40% Co; 10-20% Pd. From electrolytic Cu and Co with <0.01% C	MP: break in time-temp. curve during cooling Pt-Rh thermocouple	

Symbol	Nominal Composition, %			Melting Point	
	Cu	Pd	Co	°R	°K
O	60	30	10	2441	1356
	50	40	10	2582	1434
	50	30	20	2485	1380
	40	30	30	2526	1403

MELTING POINT -- COPPER + PALLADIUM + COBALT

MELTING POINT -- COPPER + PALLADIUM + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Panteleimonov, L. A., Kurpina, V. V., et al.	56-31	2440-2582	Ternary system: 40-60% Cu; 30-40% Pd; 10-30% Co. From electrolytic Cu and Co with <0.01% C	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	

PROPERTIES OF COPPER + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 57% Cu	662 lb_m/ft^3	10.6 g/cm^3
Melting Point 57% Cu .	2385 °R	1325 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	662	10.6
	□	661.7 ± 1.2	10.60 ± 0.02

		°R	°K
Melting Point:			
	□	2385	1325

	Btu/lb_m	cal/g
Heat of Fusion:		

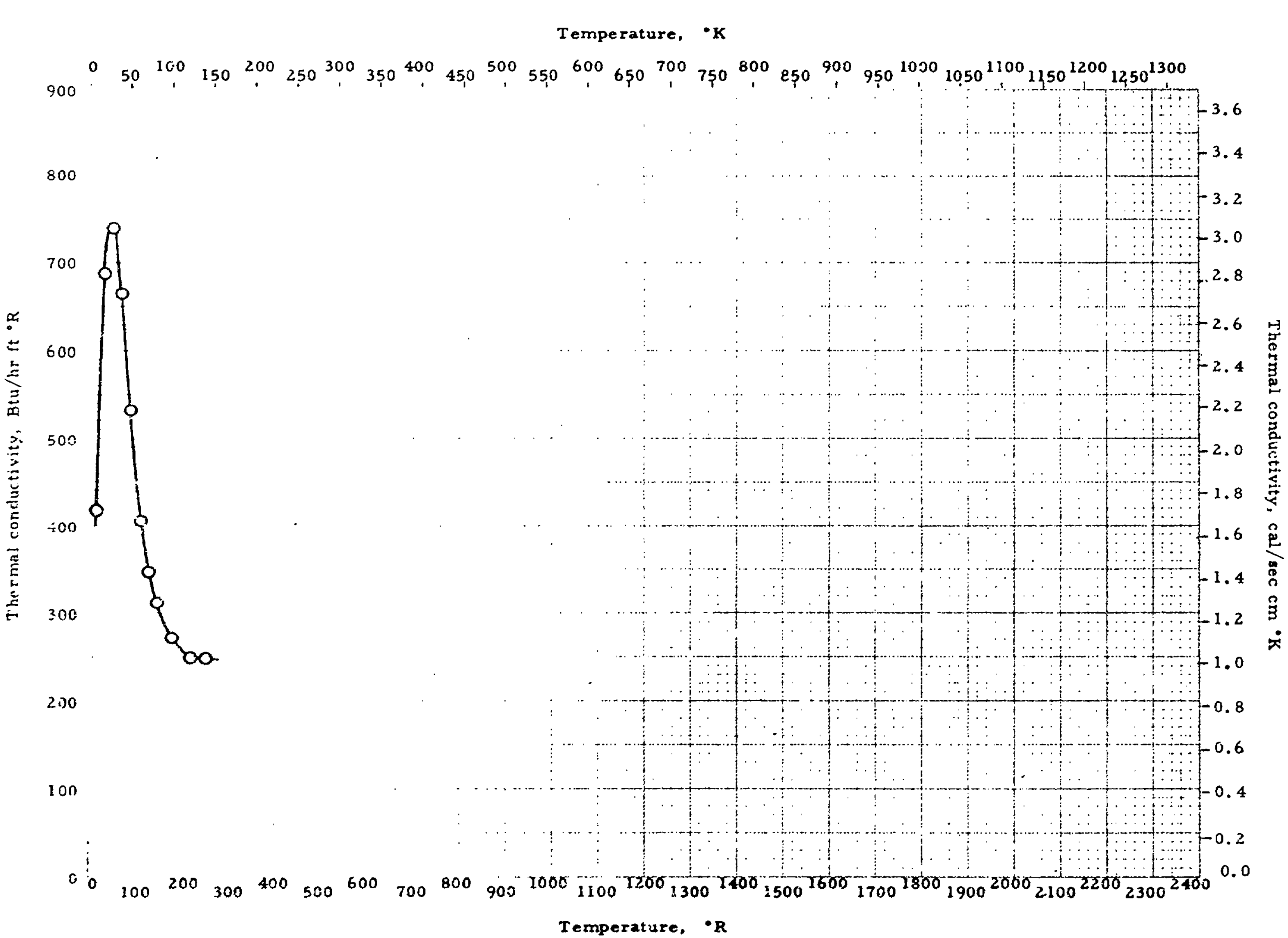
	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF COPPER + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilhelm, H. A. and Carlson, O. N.	49-49	Room	U Cu_5: 57.2% Cu:42.8% U	ρ : not given	Inductively melted in ZrO_2 or BeO crucible in vacuum from 99.9 +% U and electrolytic Cu
□	Ibid.	49-49	Room 2385	Same as above	ρ : computed from X-ray measurements of lattice MP : break in time-temp curve	Same as above

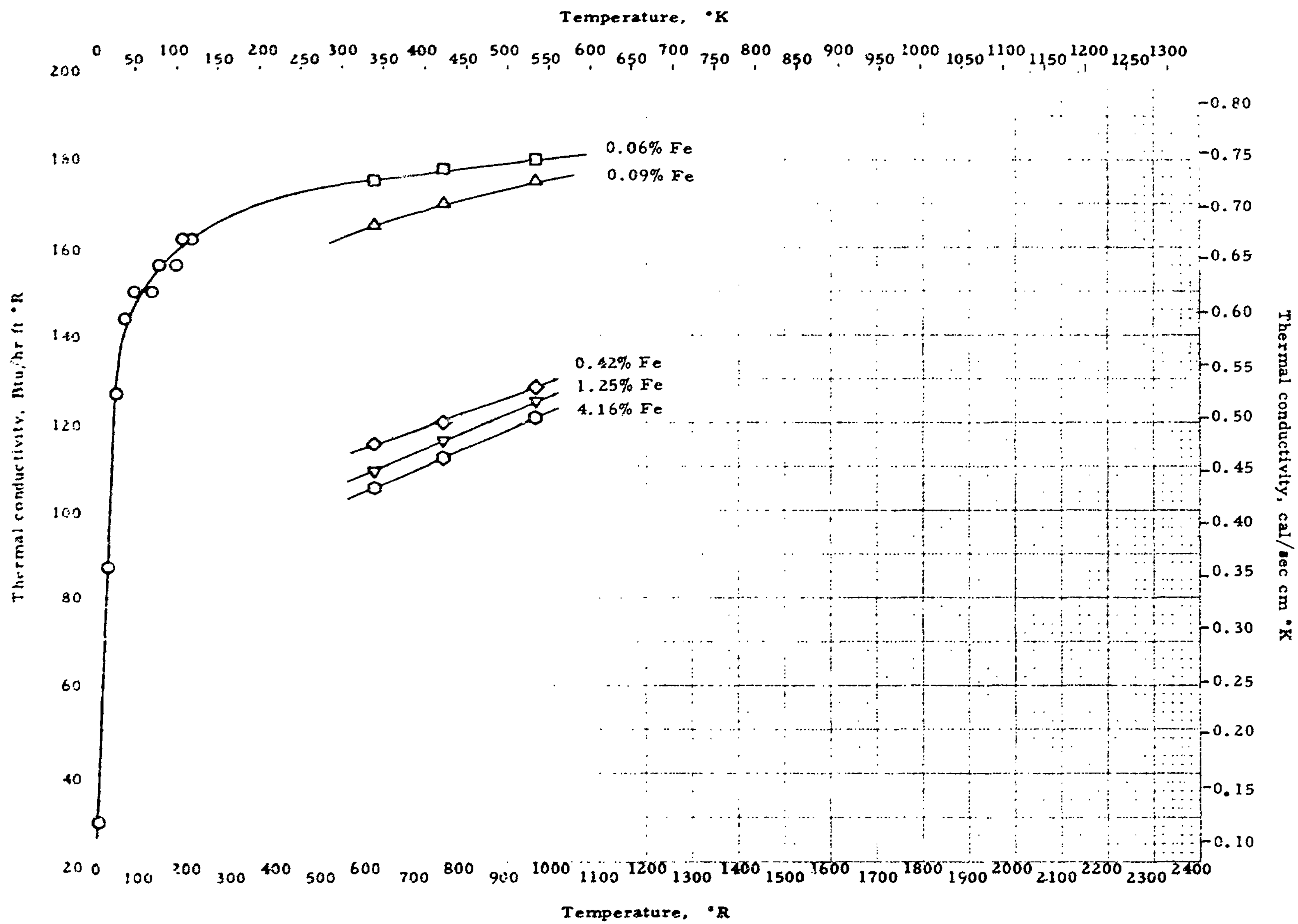


THERMAL CONDUCTIVITY -- COPPER + GERMANIUM

THERMAL CONDUCTIVITY -- COPPER + GERMANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	White, G. K., and Woods, S. B.	55-4	18-252	0.02% Ge	Axial heat flow in rod; guarded heat source and sample	Auth. est. accuracy ± 5%

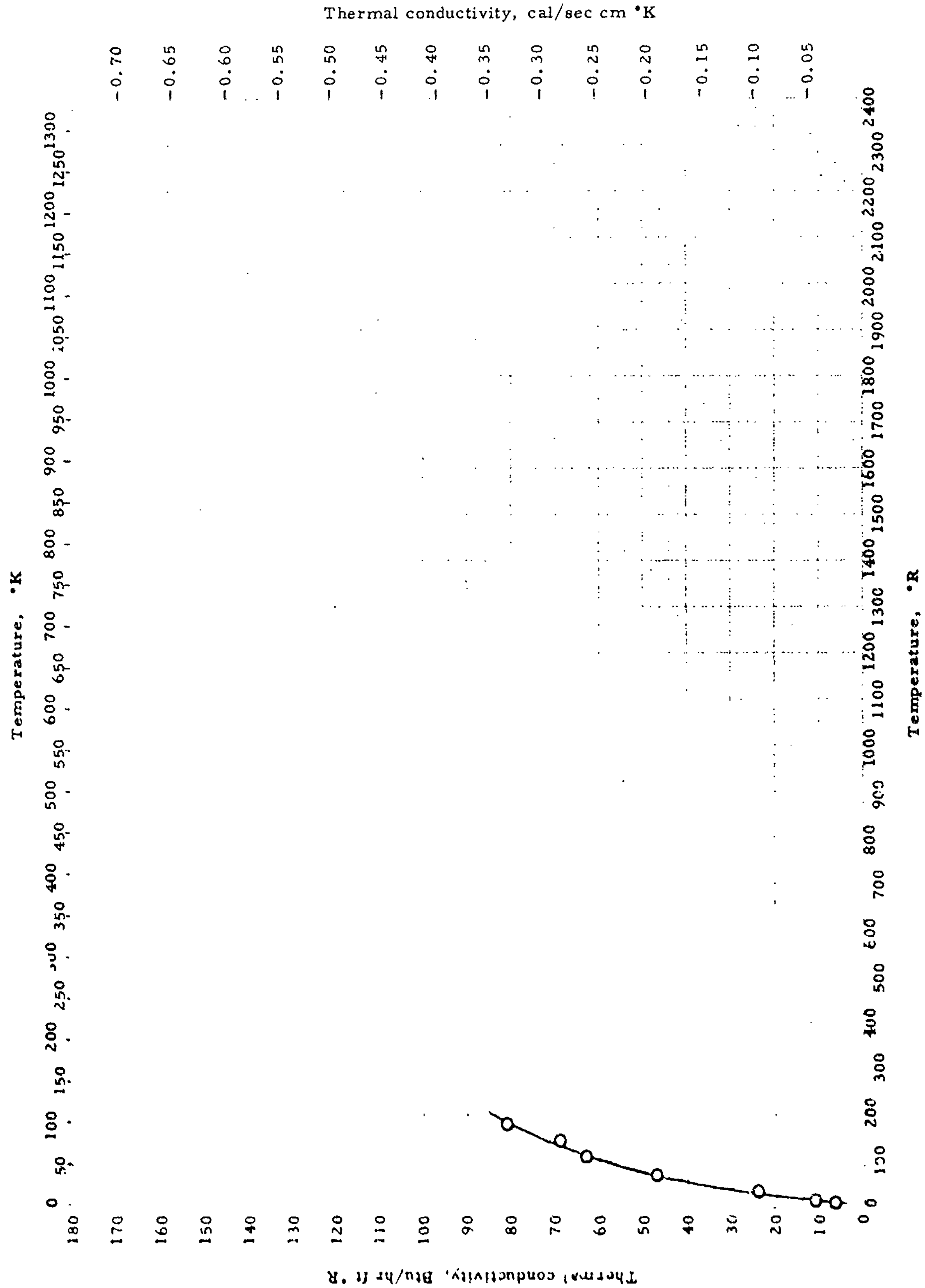


THERMAL CONDUCTIVITY -- COPPER + IRON

THERMAL CONDUCTIVITY -- COPPER + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	White, G.K., and Woods, S.B.	55-4	18-216	0.056% Fe	Axial heat flow in rod; guarded heat source and sample	Auth. est. accuracy ± 5%
□	Goglia, M.J., Hawkins, G.A., and Deverall, J.E.	52-7	610-960	0.061 ± 0.001% Fe; 0.16 ± 0.002% P; prepared from electrolytic tough pitch copper	Axial heat flow in rod; guarded heat source and sample	Auth. est. accuracy ± 5%
△	Ibid.	52-7	610-960	0.089 ± 0.003% Fe; 0.015 ± 0.002% P; raw material same as above	Same as above	Same as above
◇	Ibid.	52-7	610-960	0.42 ± 0.03% Fe; 0.012 ± 0.001% P; raw material same as above	Same as above	Same as above
▽	Ibid.	52-7	610-960	1.25% Fe; 0.014% P; raw material same as above	Same as above	Same as above
○	Ibid.	52-7	610-960	4.16 ± 0.02% Fe; 0.018% P; raw material same as above	Same as above	Same as above

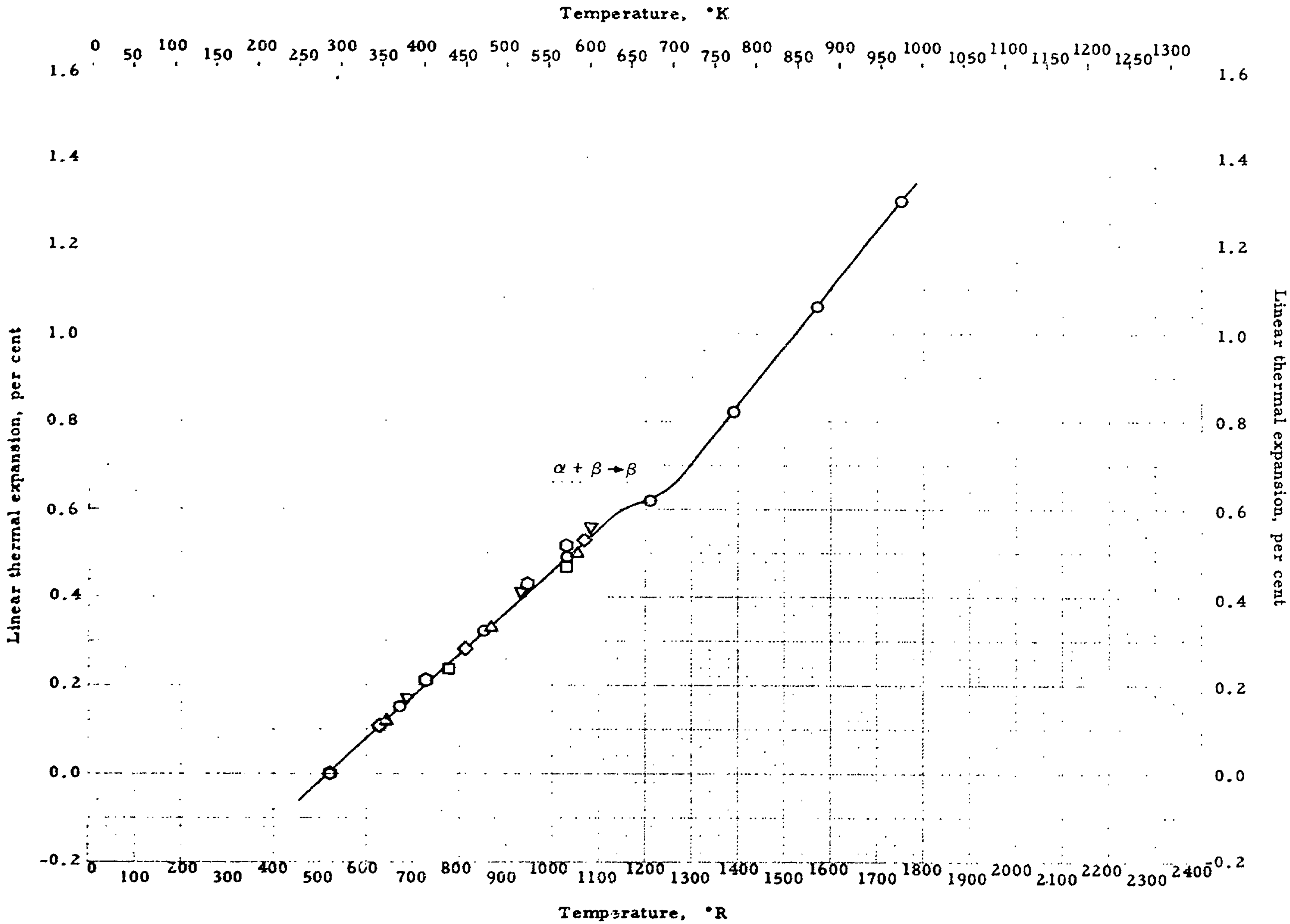


THERMAL CONDUCTIVITY -- COPPER + PHOSPHORUS

THERMAL CONDUCTIVITY -- COPPER + PHOSPHORUS

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. L., Roder, A. M., and Rogers, W. M.	57-37	10-180	Phosphorized deoxidized copper: 0.027% P; 0.01% ea. Fe, Ag, Zn; 0.001% ea. Ni, Si; <0.0001% ea. Pb, Mg, Mn, Cr, Al; $\rho = 556\ lb_m/ft^3$; average grain size 0.13 x 0.028mm longitudinal, 0.036 x 0.036mm transverse	Axial heat flow in rod; guarded heat source and sample	Tested in vacuum ($<10^{-6}$ mm Hg)

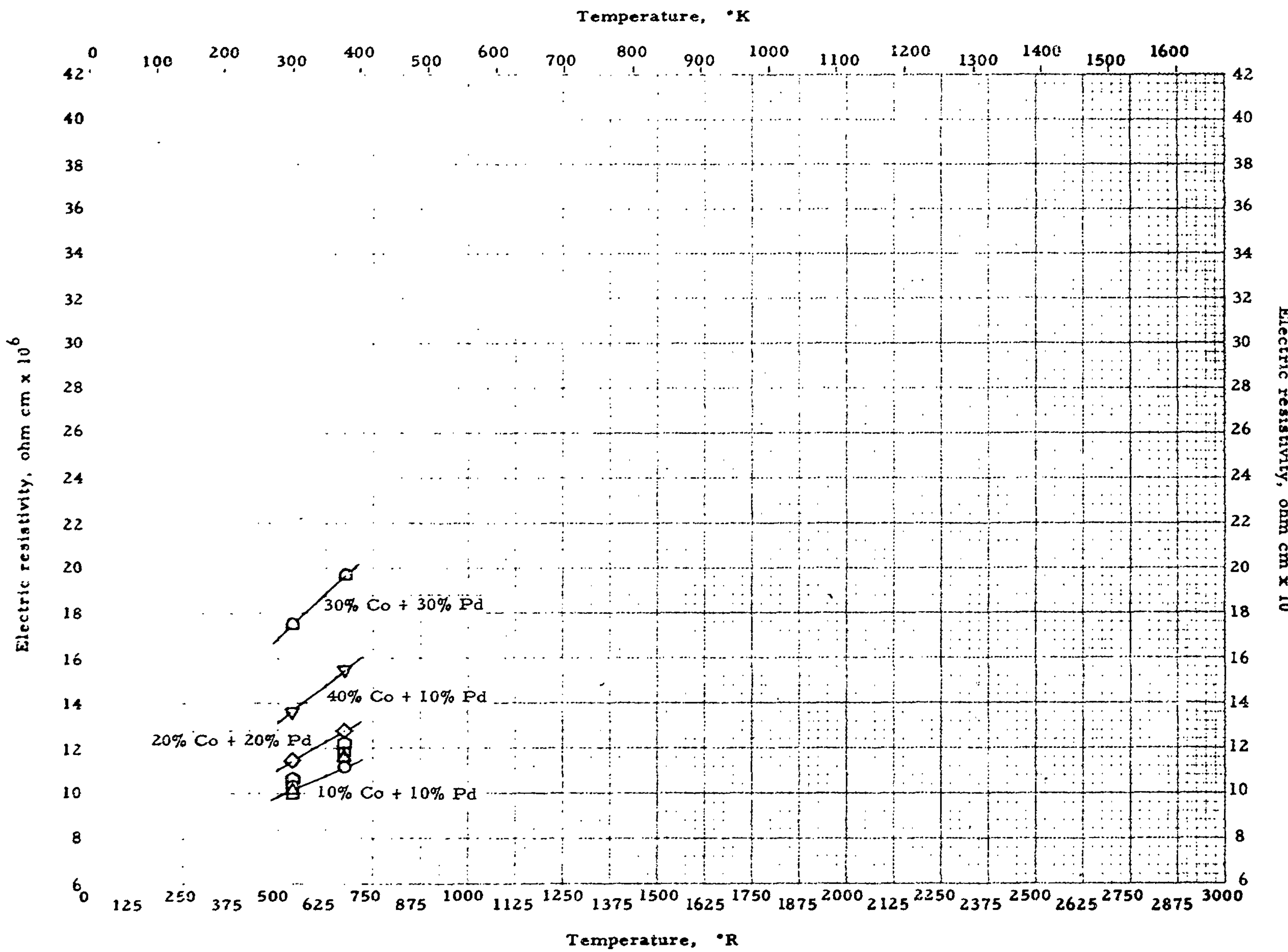


LINEAR THERMAL EXPANSION -- COPPER + SILVER

LINEAR THERMAL EXPANSION -- COPPER + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Wolff, K.	49-12	519-1752	93% Cu; 7% Ag	Dilatometer, Leitz type	Homogenized; heated at 1.6°C/min. during test
□	Waldhauser, I.	55-117	528-1032	89.5% Cu; 10.4% Ag; 0.066% As; 0.030% P	Leitz-Bollenrath quartz tube differential dilatometer. Temp. meas. by calibrated thermocouple	Cast, expansion near MP measured, but not reported
△	Ibid.	55-117	528-1032	79.8% Cu; 20.1% Ag; 0.058% As; 0.027% P	Same as above	Same as above
◇	Ibid.	55-117	528-1032	69.6% Cu; 30.0% Ag; 0.058% As; 0.021% P	Same as above	Same as above
▽	Ibid.	55-117	528-1032	59.1% Cu; 40.9% Ag; 0.043% As; 0.019% P	Same as above	Same as above
⬡	Ibid.	55-117	528-1032	50.01% Cu; 49.98% Ag; 0.032% As; 0.0160 P	Same as above	Same as above

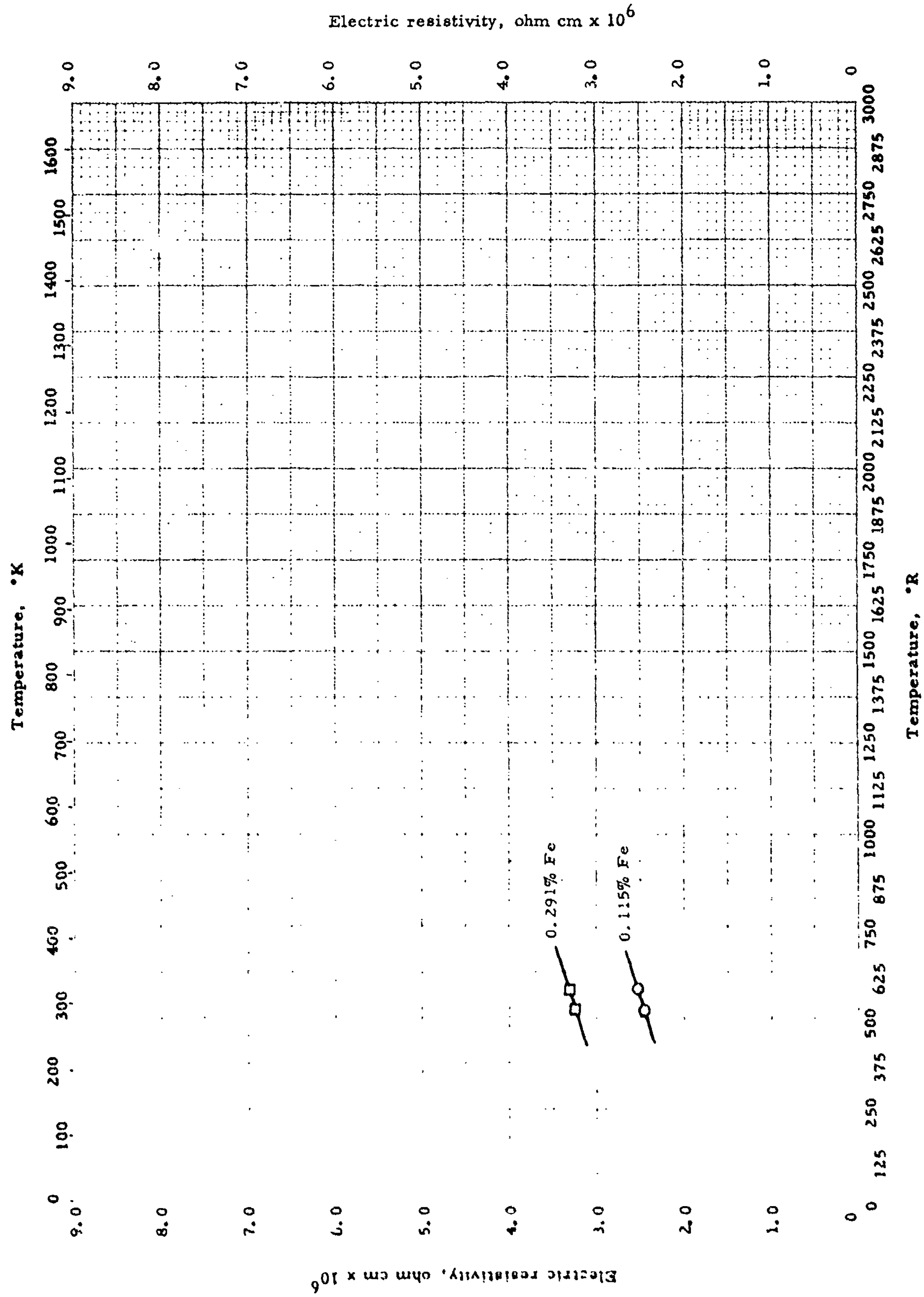


ELECTRIC RESISTIVITY -- COPPER + COBALT + PALLADIUM

ELECTRIC RESISTIVITY -- COPPER + COBALT + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., et al.	56-31	537-672	80% Cu; 10% Co; 10% Pd	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	70% Cu; 20% Co; 10% Pd	Same as above	Same as above
△	Ibid.	56-31	537-672	60% Cu; 30% Co; 10% Pd	Same as above	Same as above
◇	Ibid.	56-31	537-672	60% Cu; 20% Co; 20% Pd	Same as above	Same as above
▽	Ibid.	56-31	537-672	50% Cu; 40% Co; 10% Pd	Same as above	Same as above
○	Ibid.	56-31	537-672	40% Cu; 40% Co; 20% Pd	Same as above	Same as above
◻	Ibid.	56-31	537-672	40% Cu; 30% Co; 30% Pd	Same as above	Same as above

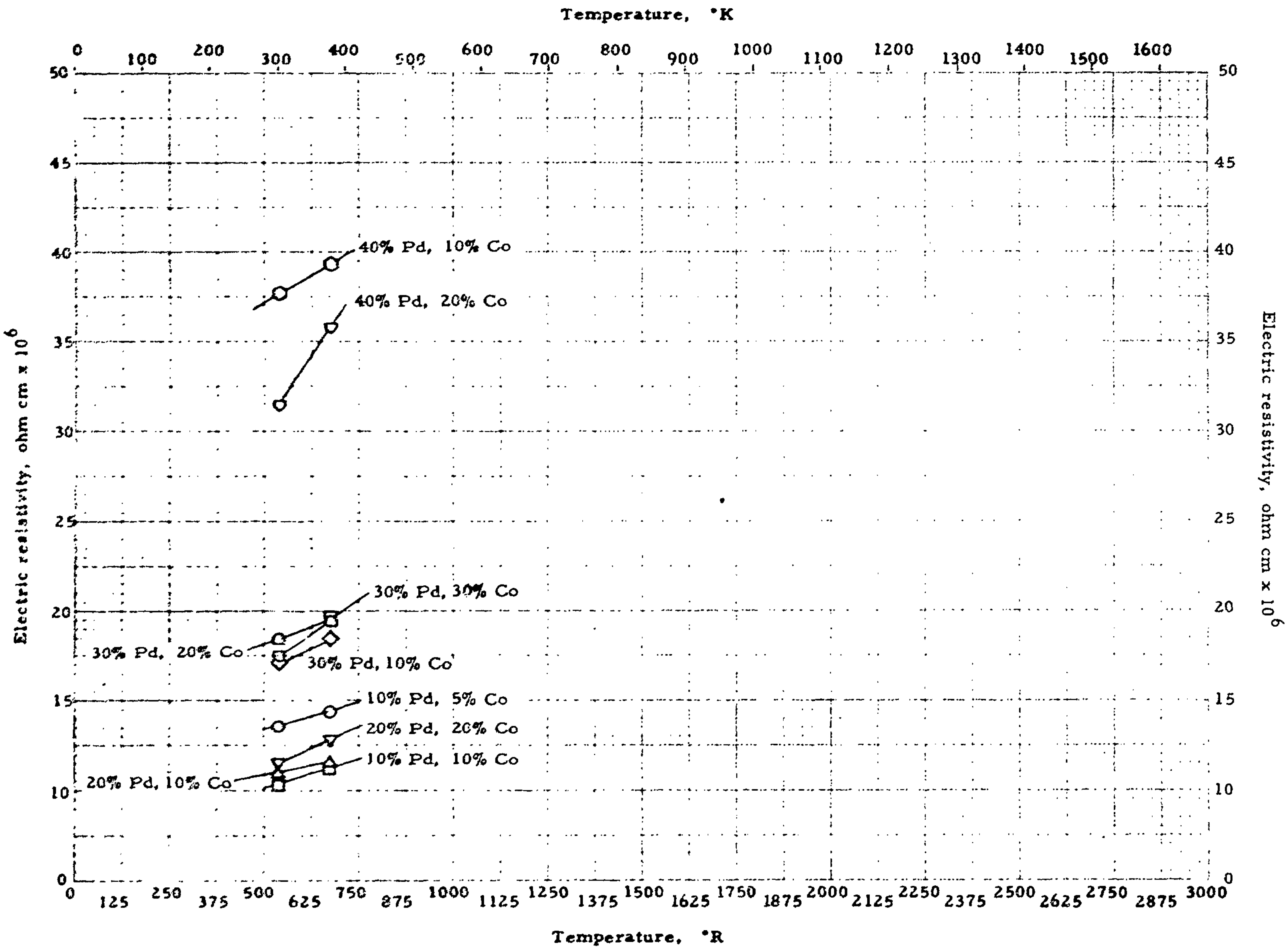


ELECTRIC RESISTIVITY -- COPPER + IRON

ELECTRIC RESISTIVITY -- COPPER + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pollock, D. D. and Finch, D. I.	56-114	519-564	0.115% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. others	Kelvin double bridge	Auth. also gives data for alloys in the system Cu + Mn + Ni + Fe
□	Ibid.	56-114	519-564	0.291% Fe; <0.008% Mg; <0.004% Si; <0.001% ea. others	Same as above	Same as above

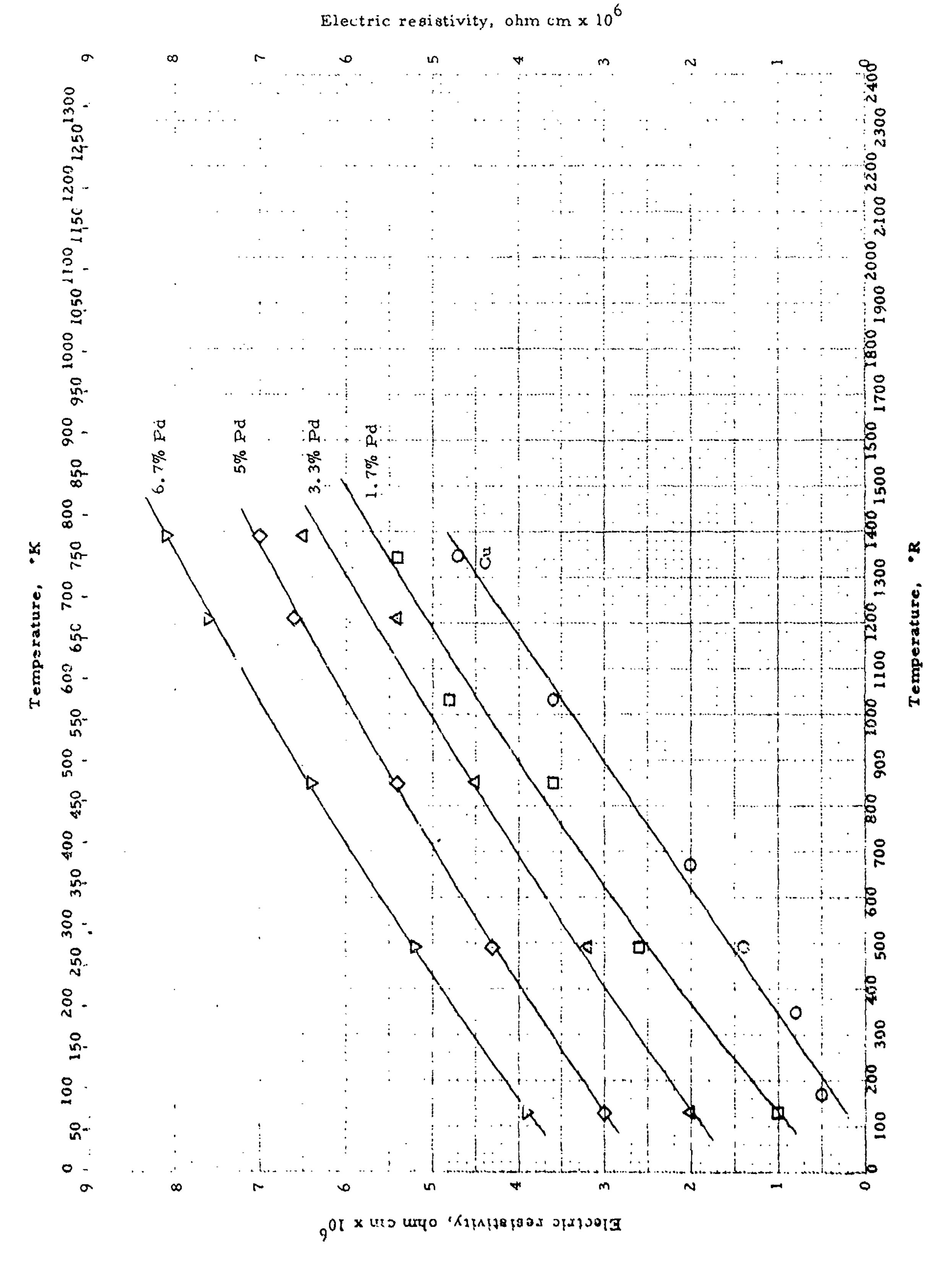


ELECTRIC RESISTIVITY -- COPPER + PALLADIUM + COBALT

ELECTRIC RESISTIVITY -- COPPER + PALLADIUM + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., et al.	56-31	537-672	85% Cu; 10% Pd; 5% Co	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	80% Cu; 10% Pd, 10% Co	Same as above	Same as above
△	Ibid.	56-31	537-672	70% Cu; 20% Pd; 10% Co	Same as above	Same as above
◇	Ibid.	56-31	537-672	60% Cu; 30% Pd; 10% Co	Same as above	Same as above
▽	Ibid.	56-31	537-672	60% Cu; 20% Pd; 20% Co	Same as above	Same as above
○	Ibid.	56-31	537-672	50% Cu; 40% Pd; 10% Co	Same as above	Same as above
◻	Ibid.	56-31	537-672	50% Cu, 30% Pd; 20% Co	Same as above	Same as above
▽	Ibid.	56-31	537-672	40% Cu, 40% Pd; 20% Co	Same as above	Same as above
○	Ibid.	56-31	537-672	40% Cu; 30% Pd; 30% Co	Same as above	Same as above

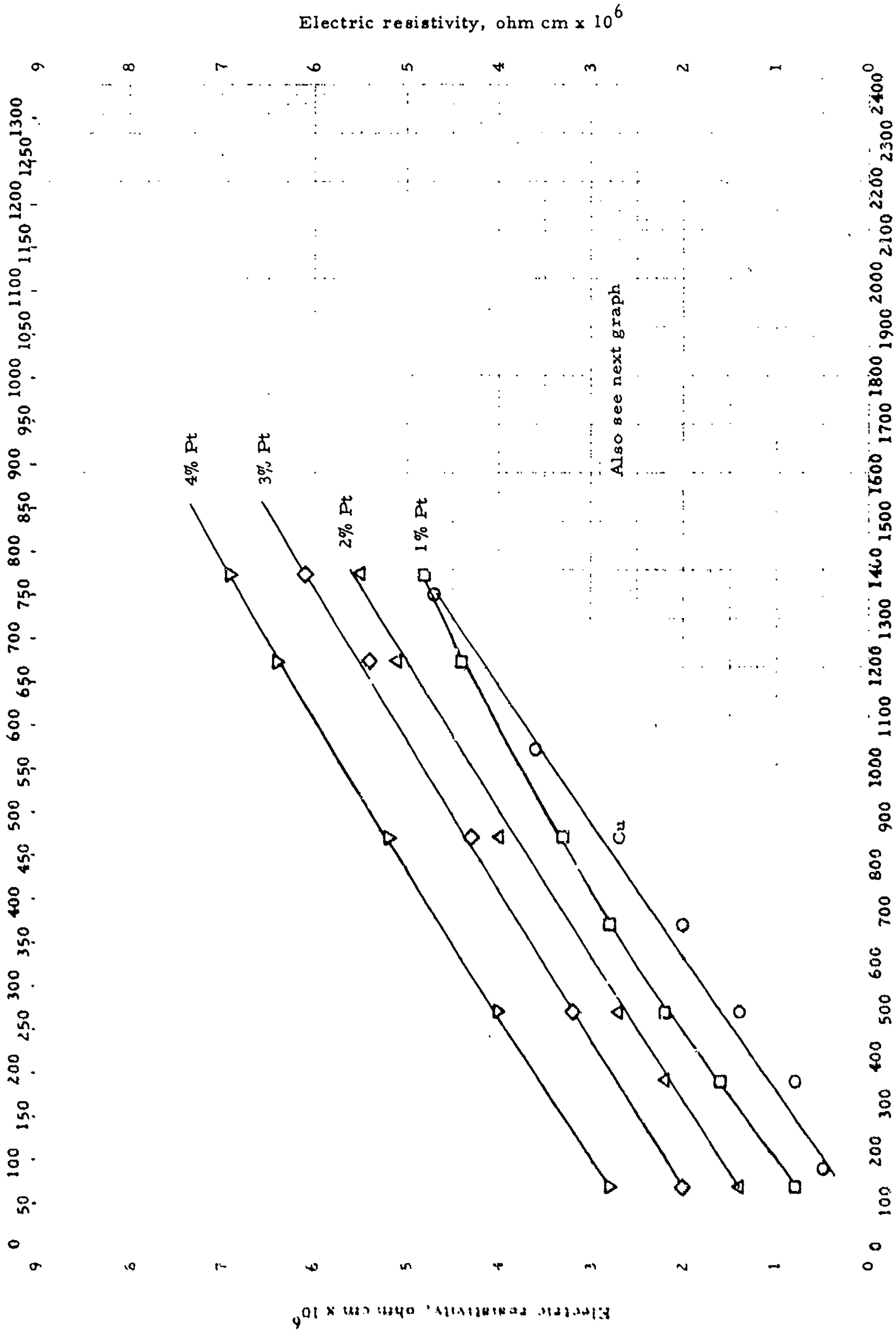


ELECTRIC RESISTIVITY -- COPPER + PALLADIUM

ELECTRIC RESISTIVITY -- COPPER + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F. A.	56-46	132-1392	99.99% pure Cu	Potential drop	Heated 24 hr. at 900°C, swaged, annealed 1 hr at 500°C
□	Ibid.	56-46	132-1392	1.7% Pd; prepared from 99.99% pure raw materials	Same as above	Vacuum melted 100°C above melting point, homogenized 24 hr. at 900°C, swaged, annealed 1 hr. at 500°C
△	Ibid.	56-46	132-1392	3.3% Pd; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-46	132-1392	5% Pd; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-46	132-1392	6.7% Pd; raw materials same as above	Same as above	Same as above

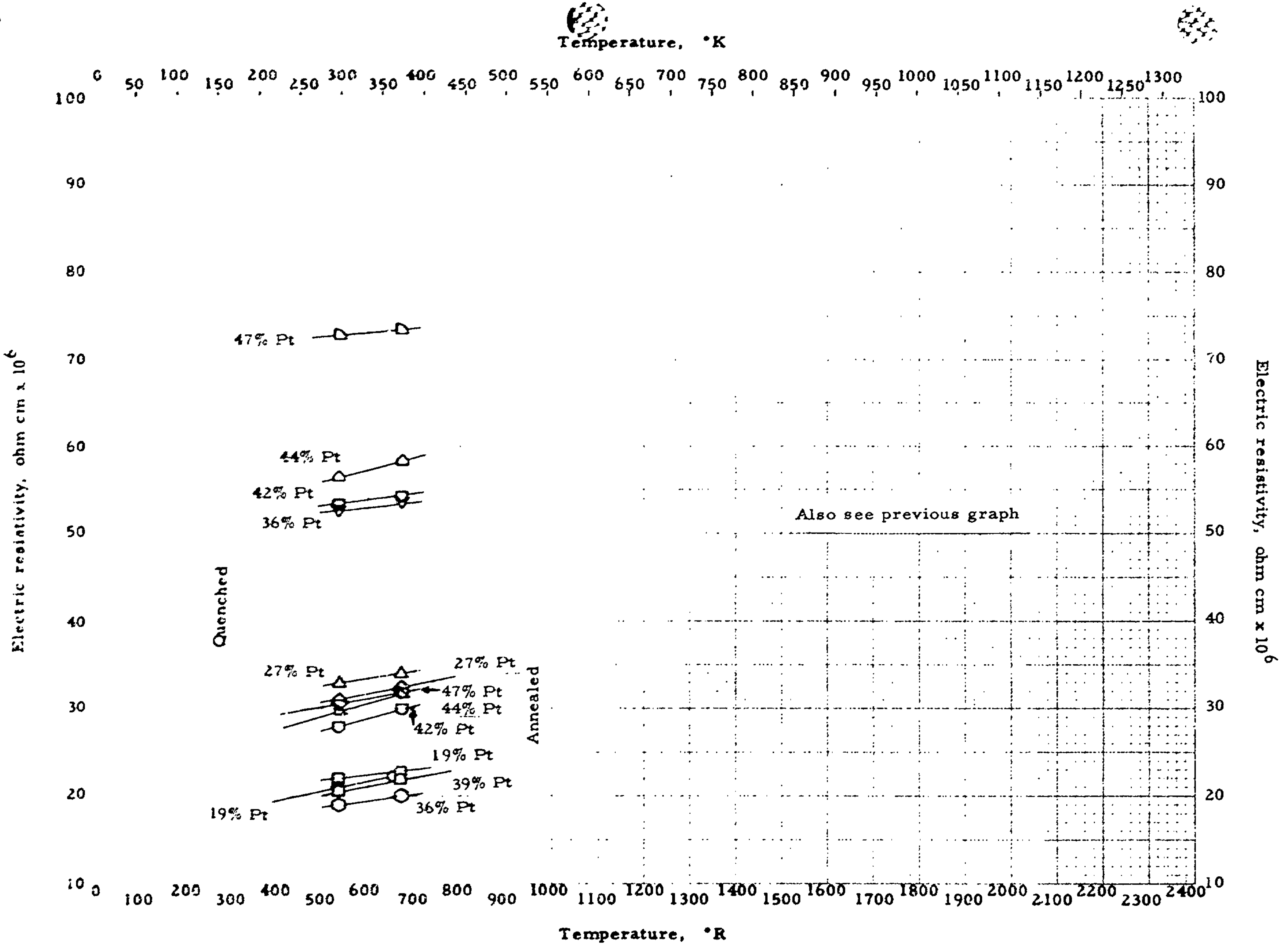


ELECTRIC RESISTIVITY -- COPPER + PLATINUM

ELECTRIC RESISTIVITY -- COPPER + PLATINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F. A.	56-46	132-1392	99.99% pure Cu	Potential drop	Heated 24 hr. at 900°C, swaged, annealed 1 hr at 500°C
□	Ibid.	56-46	132-1392	1.0% Pt; prepared from 99.99% pure raw material	Same as above	Vacuum melted 100°C above melting point, homogenized 24 hr. at 900°C, swaged, annealed 1 hr. at 500°C
△	Ibid.	56-46	132-1392	2.0% Pt; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-46	132-1392	3.0% Pt; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-46	132-1392	4.0% Pt; raw materials same as above	Same as above	Same as above



ELECTRIC RESISTIVITY -- COPPER + PLATINUM

ELECTRIC RESISTIVITY -- COPPER + PLATINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Rudnitskii, A. A.	56-70	537-672	19.40% Pt	Potential drop	Quenched from 900°C
□	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
△	Ibid.	56-70	537-672	26.74% Pt	Same as above	Quenched from 900°C
◇	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
▽	Ibid.	56-70	537-672	35.96% Pt	Same as above	Quenched from 900°C
○	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
◻	Ibid.	56-70	537-672	38.9% Pt	Same as above	Annealed
▽	Ibid.	56-70	537-672	41.58% Pt	Same as above	Quenched from 900°C
◻	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
△	Ibid.	56-70	537-672	43.70% Pt	Same as above	Quenched from 900°C
◺	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
◻	Ibid.	56-70	537-672	47.43% Pt	Same as above	Quenched from 900°C
♡	Ibid.	56-70	537-672	Same as above	Same as above	Annealed

PROPERTIES OF NICKEL + COPPER + X (K-Monel)

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	528 lb_m/ft^3	8.46 g/cm^3
Melting Point	2900°R *	1610°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Metals Handbook (Ref. 48-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	O	527.9	8.456
	□	528	8.46

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

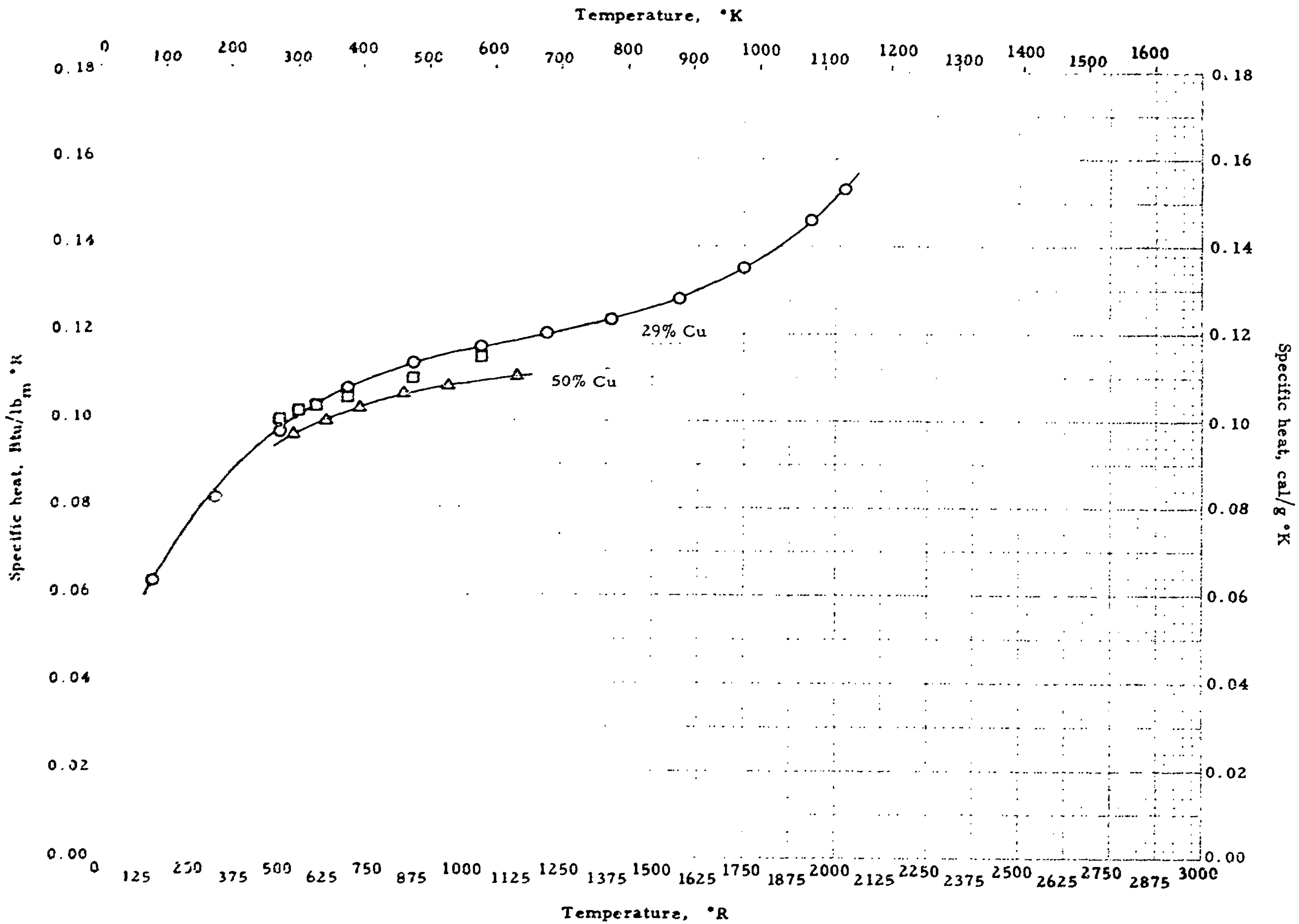
	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF NICKEL + COPPER + X
(K-Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5	528	K-Monel nominal: 66% Ni; 30% Cu; 3% Al	ρ: weight and volume by water displacement	Hot rolled, annealed 1 hr. at 900°C, water quenched
□	Lucks, C. F., Thompson, H. B. et al.	51-65	528	K-Monel: 65.51% Ni; 20.23% Cu; 3.02% Al; 0.86% Fe; 0.60% Mn; 0.13% C; 0.09% Si; 0.005% S	ρ: weight in air and in water	Same as above

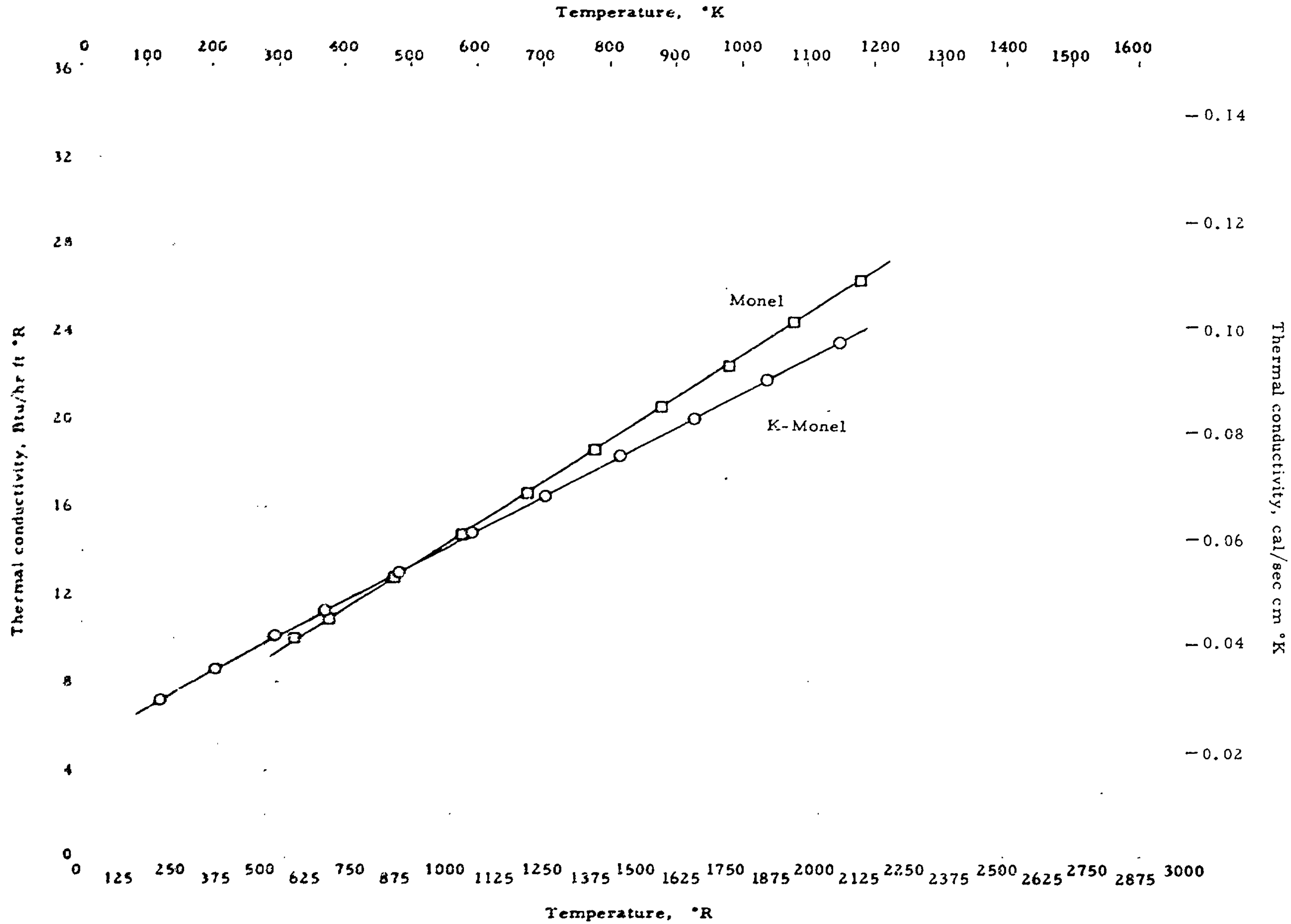


SPECIFIC HEAT -- NICKEL + COPPER + X

SPECIFIC HEAT -- NICKEL + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F., Matolich, J., and Van Valzor, J. A.	54-27 also 52-33 also 58-5	140-2040	K-Monel; nominal: 66% Ni; 29% Cu; 2.75% Al; 0.9% Fe; X	Drop method; ice calorimeter	Sample of Ref. 58-5 hot rolled, annealed 1 hr. at 1650°F, water quenched
□	Douglas, T. B., and Dever, J. L.	53-39 also 55-16	492-1032	Monel; 67.1% Ni; 29.3% Cu; 1.8% Fe; 1.0% Mn; 0.18% C; 0.07% Si	Drop method; ice calorimeter	Auth. est. accuracy ± 2%
△	Persoz, B.	40-4	510-1130	50% Ni; 50% Cu	Guarded sample	Auth. est. accuracy 0.5%

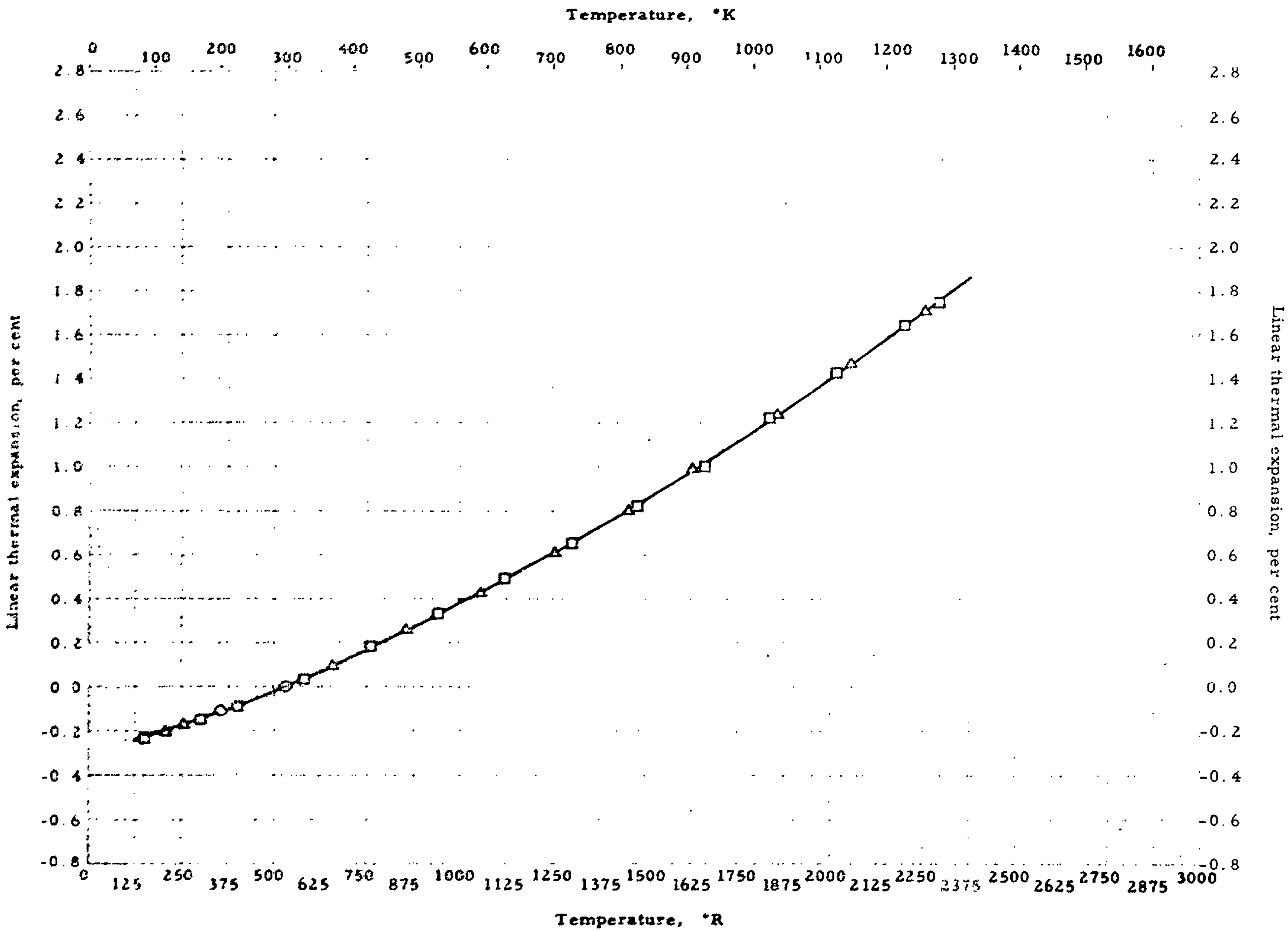


THERMAL CONDUCTIVITY -- NICKEL + COPPER + X

THERMAL CONDUCTIVITY -- NICKEL + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5 also 51-65	210-2060	K-Monel: 65.51% Ni, 29.23% Cu; 3.02% Al; 0.86% Fe, 0.60% Mn; 0.13% C; 0.09% Si, 0.005% S	Comparative; rods with Armco Iron standard	Hot rolled, annealed 1 hr. at 1650°F; water quenched. ρ = 528 lb_m/ft^3
□	Silverman, L.	53-2	582-2112	Monel: 66.2% Ni, 30.0% Cu; 1.88% Fe; 0.919% Mn; 0.407% Co; 0.40% C; 0.135% Si; 0.032% Mg	Comparative; rods with Pb as primary standard, "Advance" as working standard	

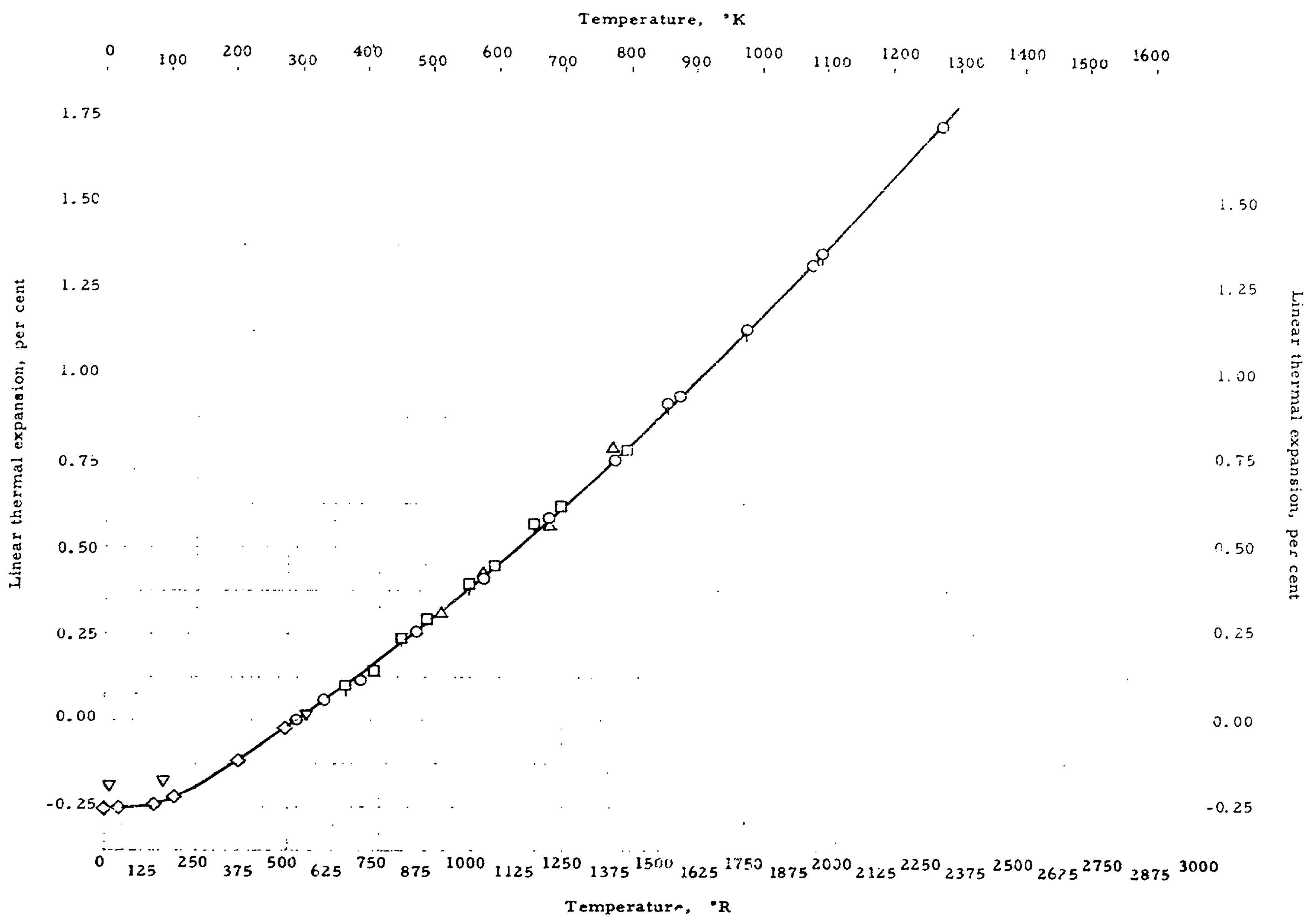


LINEAR THERMAL EXPANSION -- NICKEL + COPPER + X
(K-Monel)

LINEAR THERMAL EXPANSION -- NICKEL + COPPER + X
(K-Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Perry, S.	45-6	360-538	K Monel: 66.0% Ni; 29.0% Cu; 2.75% Al; 0.90% Fe; 0.50% Si; 0.40% Mn; 0.15% C	Quartz tube dilatometer with dial indicator. Temp. by thermocouple	Auth. est. accuracy ± 3.4%
□	Lucks, C. F., Thompson, H. B. et al.	51-65	150-2293	K Monel: 65.51% Ni; 29.23% Cu; 3.02% Al; 0.86% Fe; 0.60% Mn; 0.13% C; 0.09% Si; 0.005% S. ρ = 528 lb_m/ft^3	Quartz tube dilatometer, tested at 1.5-2.5°C/min. rise time in argon	Hot rolled, annealed 1 hr. at 1650°F, water quenched
△	Lucks, C. F. and Deem, H. W.	58-5	210-2260	K-Monel: nominal: 66% Ni; 30% Cu; 3.5% Al; 1.5% Fe; 0.20% C max; <5% others	Quartz tube dilatometer in vac.	Hot rolled, annealed 1 hr. at 1650°F, water quenched

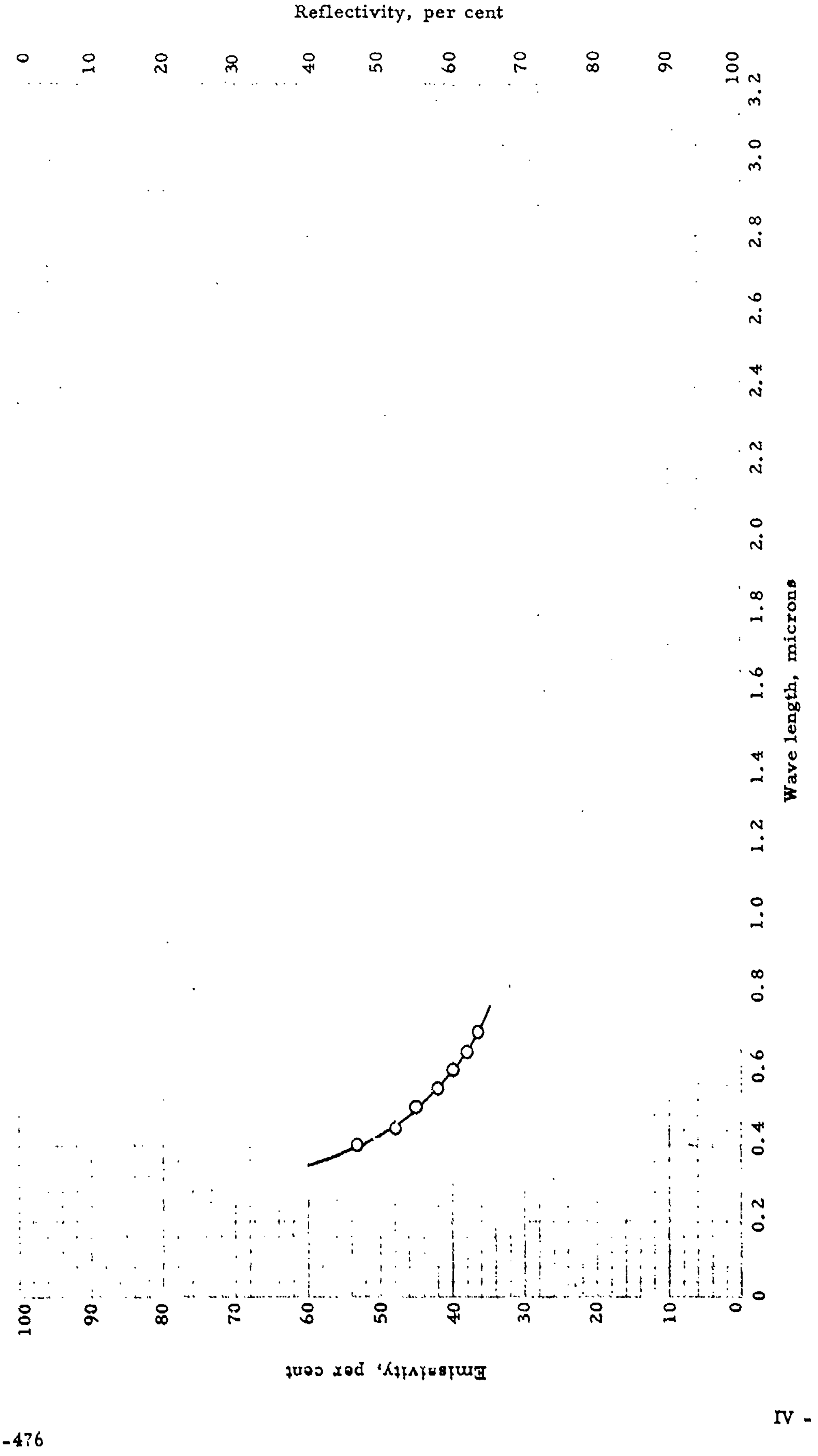


LINEAR THERMAL EXPANSION -- NICKEL + COPPER + X
(Monel)

LINEAR THERMAL EXPANSION -- NICKEL + COPPER + X
(Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P.	57-134	528-2292	Monel: 66.4% Ni; 29.4% Cu	Not described here, refers to others	Annealed 3 hr. at 1000°C in pure dry H_2 furnace, cooled 150°C/hr from 1000°C to 600°C then at 35°C/hr. to 20°C ○ - heating ⍖ - cooling
□	Ibid.	57-134	528-2292	Monel: 66.2 - 67.6% Ni; 26.7 - 29.3% Cu; 2.00% Mn; 1.70% Fe; 0.24% C; 0.06% S	Same as above	Hot rolled; avg. of 4 samples within range of ± 1%
△	Ibid.	57-134	528-2292	Modified Monel: 61.0% Ni; 25% Cu; 9.0% Sn; 3.5% Fe; 0.75% ea. Mn, Si	Same as above	Cast in sand mold. Avg. of heating and cooling range of ± 1%
◇	Laquer, H.L.	52-39	7-540	Monel: Nominal: 67% Ni; 30% Cu; 1.41% Fe;1.0% Mn; 0.15% C; 0.10% Si; 0.01% S	Fizeau interferometer	Cold rolled
▽	Fraser, D.B., Hallet, A.C. and Hollis	55-28	0-540	Monel. Nominal: 67% Ni; 30% Cu; 1.41% Fe;1.0% Mn; 0.15% C; 0.10% Si; 0.01% S	Meas. separation of two Hg lines from diffraction grating on sample at various temp. Temp. meas. by boiling points of cooling fluids used	

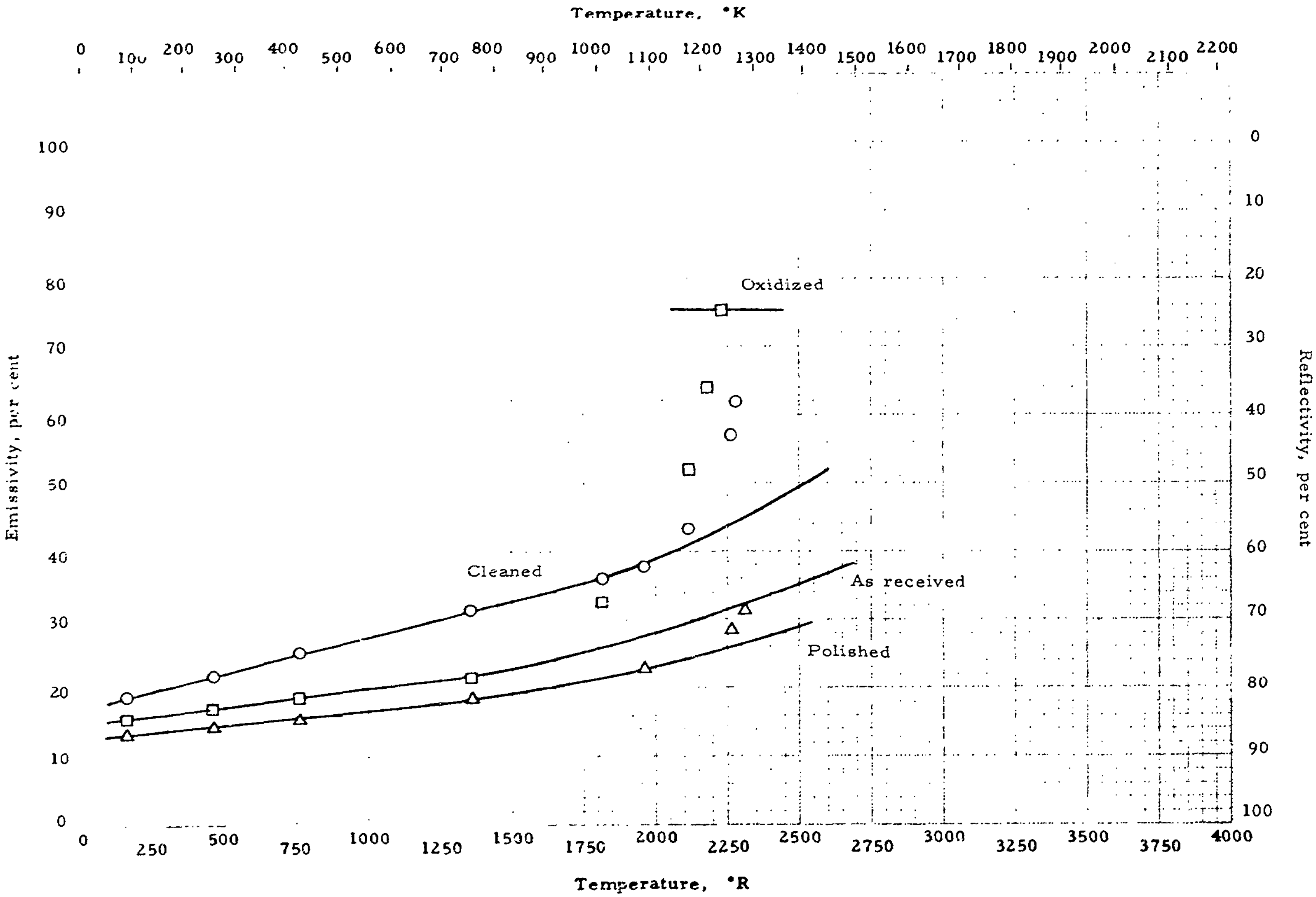


SPECTRAL EMISSIVITY -- NICKEL + COPPER + ALUMINUM
(K - Monel)

SPECTRAL EMISSIVITY -- NICKEL + COPPER + ALUMINUM
(K-Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bloom, F.K.	53-88	Room	66.7% Ni; 29.0% Cu; 2.9% Al	Spectral reflectivity by Harding spectrophotometer	Polished metallographically

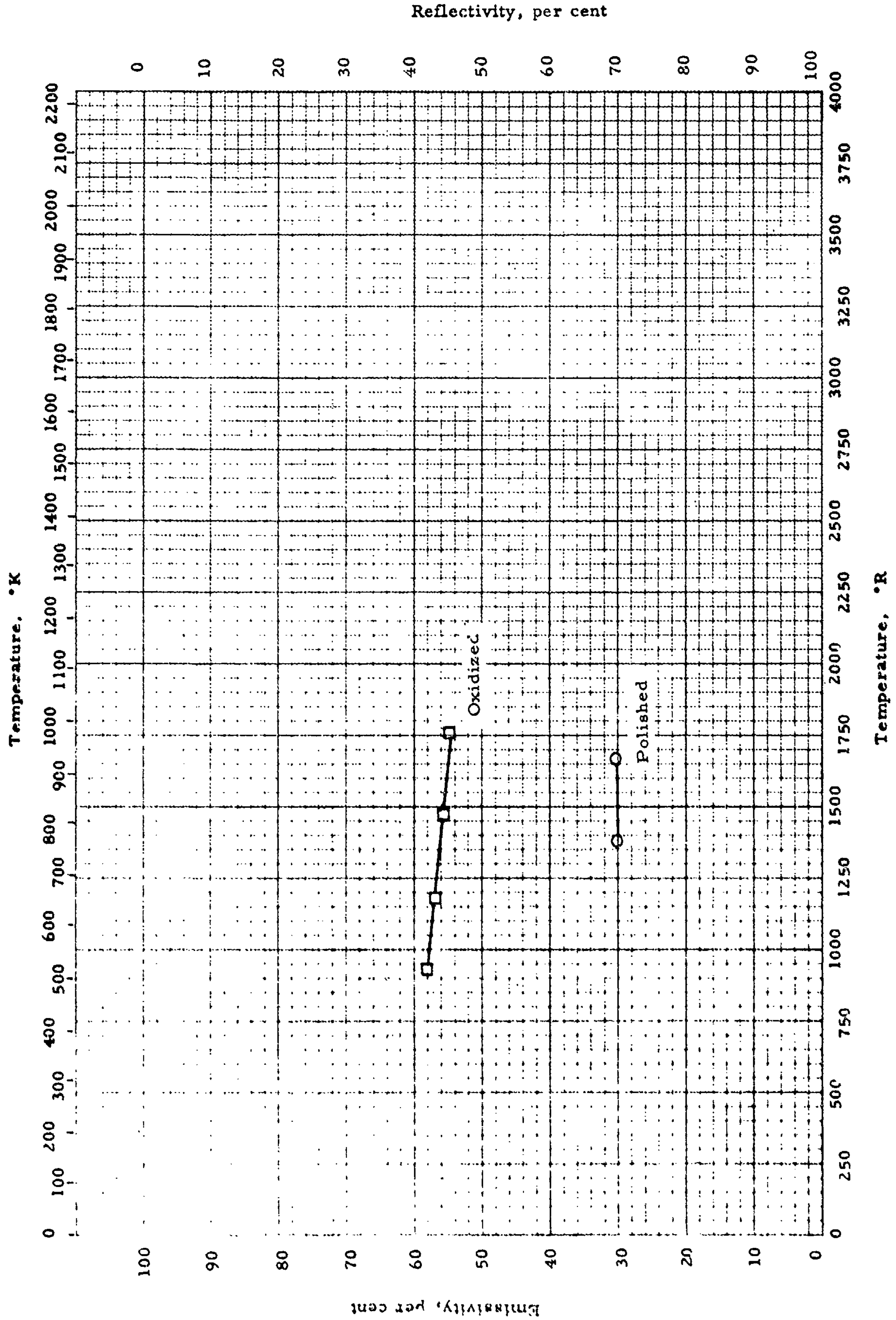


EMISSIVITY -- NICKEL + COPPER + ALUMINUM
(K-Monel)

EMISSIVITY -- NICKEL + COPPER + ALUMINUM
(K Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G. B.	54-122	160-2275	K-Monel 5700. Nominal: 66% Ni, 30% Cu; 3% Al	Total normal emissivity: comparative: radiant heat flow compared with that of a black body. Temp. by Chromel-Alumel and Cu-Constantin thermocouples	As received: wiped with toluene until clean, then with methyl alcohol
□	Ibid.	54-122	160-2230	Same as above	Same as above	Clean and smooth: scrubbed with Bon Ami, washed with water, dried, wiped with toluene, then with alcohol
△	Ibid.	54-122	160-2320	Same as above	Same as above	Polished: buffed until mirror-like and free of scratches, washed with soap and dried

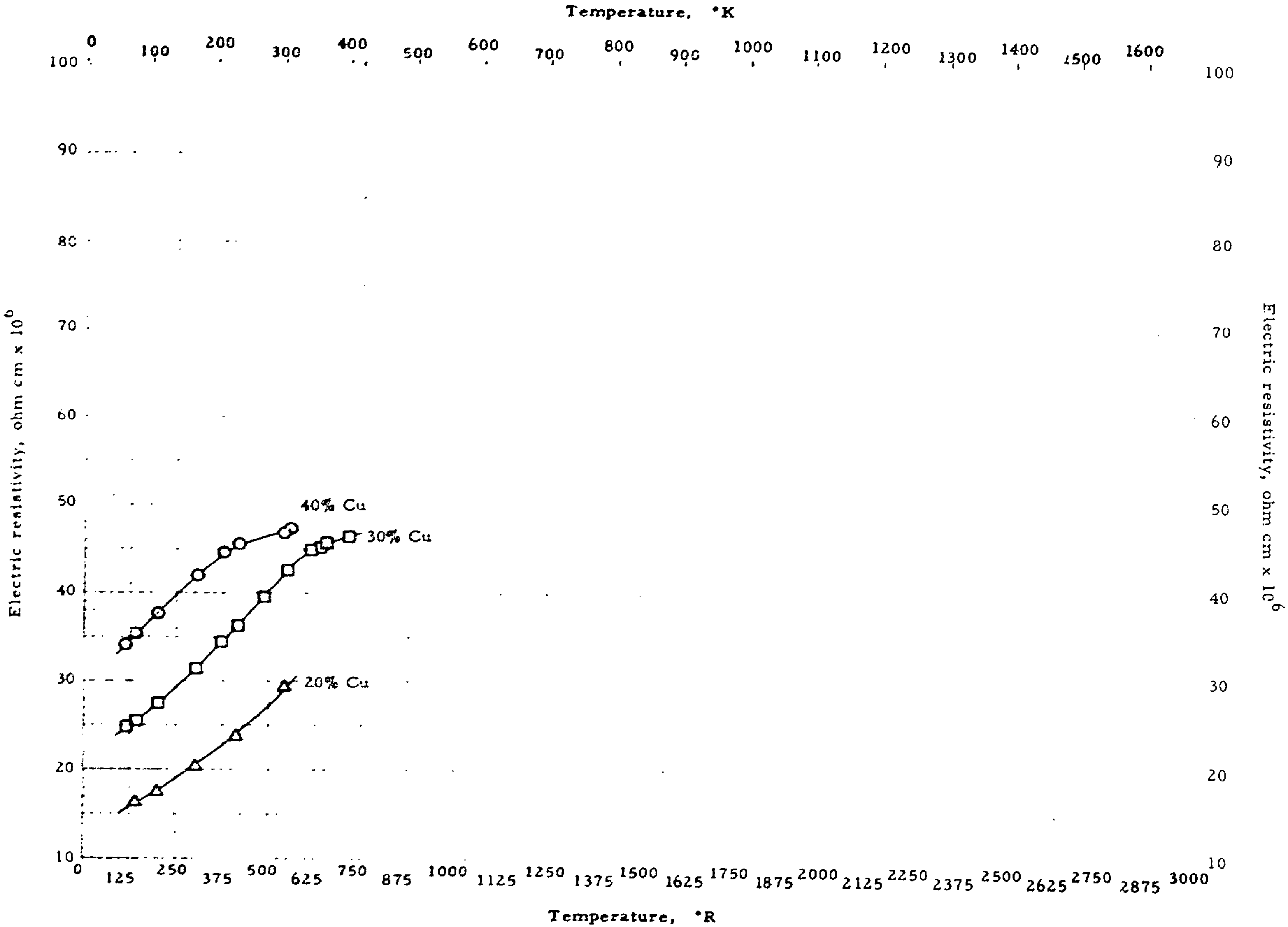


EMISSIVITY -- NICKEL + COPPER + IRON + X
(Monel)

EMISSIVITY -- NICKEL + COPPER + IRON + X
(Monel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dorward, J.G. and Reed, D.	44-8	1392-1662	Monel, nominal: 67% Ni; 30% Cu; 1.5% Fe, 1% Mn	Total normal emissivity: power dissipation of wire in vacuum to concentric cylinder, with meas. electric input. Temp. by Fe-Const. thermocouple	Polished
□	Ibid.	44-8	937-1752	Same as above	Same as above	Polished, oxidized 2 hr. at 650°C



ELECTRIC RESISTIVITY -- NICKEL + COPPER

ELECTRIC RESISTIVITY -- NICKEL + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Allison, F. E.	56-25 also 56-26	115-558	60% Ni; 40% Cu	Potential drop	
□	Ibid.	56-25 also 56-26	115-718	70% Ni; 30% Cu	Same as above	
△	Ibid.	56-25 also 56-26	139-544	80% Ni; 20% Cu	Same as above	

PROPERTIES OF NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 55% Ni	558 lb_m/ft^3	8.95% g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	○	556.9	8.921
	□	558	8.94

Melting Point:	°R	°K

Heat of Fusion:	Btu/lb_m	cal/g

Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	Room	Hastelloy C: 56.07% Ni; 15.93% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.070% C	ρ: not given	
□	Sweeny, W. O.	50-14 also 47-14	Room	Hastelloy C, AMS-5530: 16.0 - 18.0% Mo; 15.5% - 17.5% Cr; 4.5% - 7.0% Fe; 3.75 - 5.25% W; 0.15% C max	ρ: not given	

PROPERTIES OF NICKEL + MOLYBDENUM + X
(Hastelloy B)

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density	577 lb_m/ft^3	9.24 g/cm^3
Melting Point	3050°R	1690°K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	□	577	9.24

		°R	°K
Melting Point:	○	3048	1693

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF NICKEL + MOLYBDENUM + X
(Hastelloy B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Alliegro, R. A., Coffin, L. B. and Tinklepaugh, J. R.	53-18	3048	Hastelloy B; nominal: 66% Ni; 26 - 30% Mo; 4 - 7% Fe; < 0.12% C	MP: collapse of hole	MP depends upon material in contact with sample
□	Sweeney, W. O.	50-14	Room	Hastelloy B; nominal: 66% Ni, 26-30% Mo; 4 - 7% Fe; < 0.12% C	ρ: not given	Data from Union Carbon and Carbide Res. Labs.

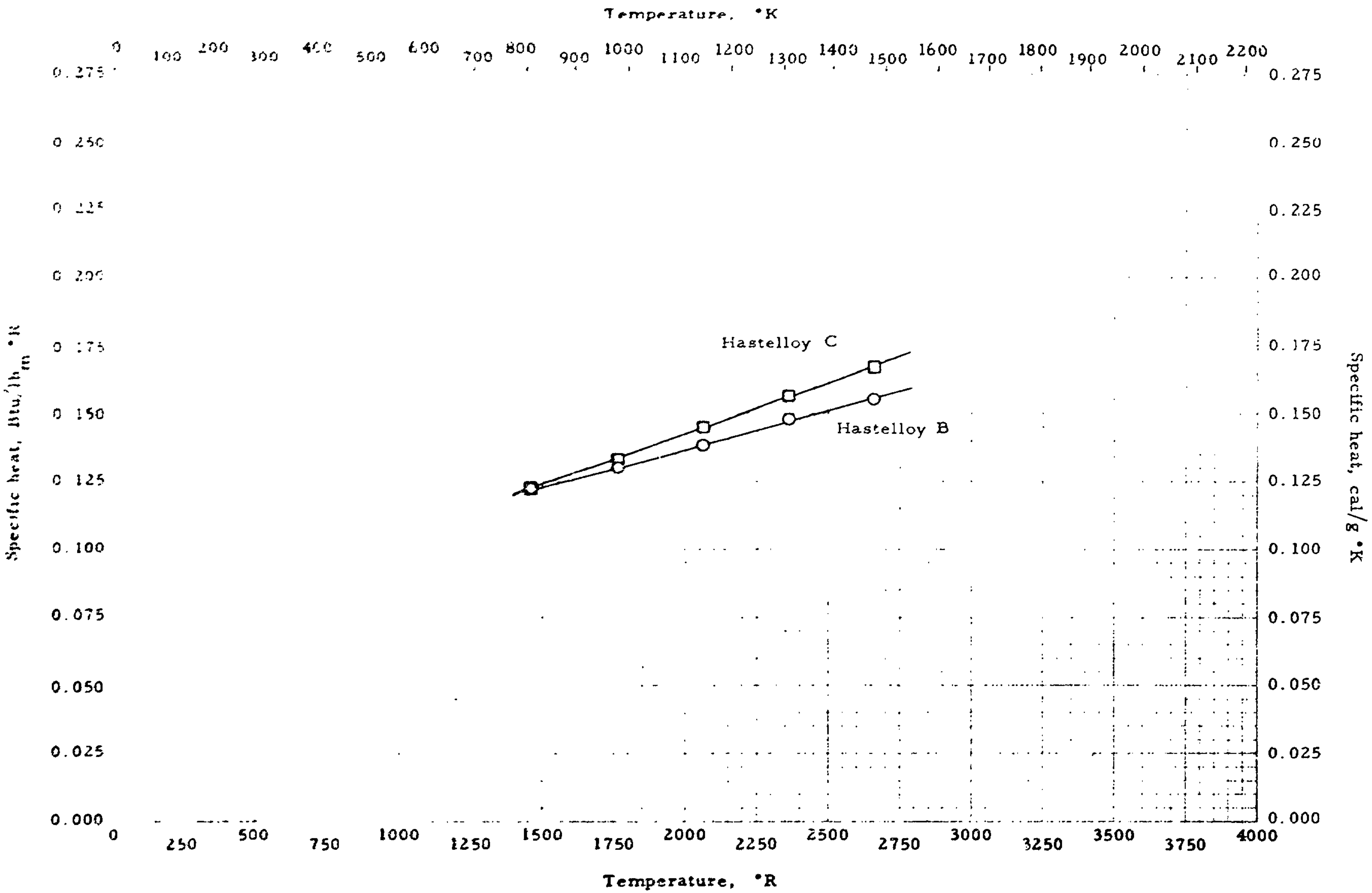
Symbol	Nominal Composition, %			Melting Point	
	Ni	Mo	Cr	°R	°K
O	40	30	30	2796	1553
	55	22.5	22.5	2814	1563

PROPERTIES OF NICKEL + MOLYBDENUM + CHROMIUM

PROPERTIES OF NICKEL + MOLYBDENUM + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Binder, I., and Moskowitz, D.	55-76	2796-2814	Alloy series 40-55% Ni; 22.5-30% ea. Cr, Mo; for composition see reported values	MP: visual observation of powder in graphite crucible; optical pyrometer est. accurate ± 25°C	Also see nickel + chromium + molybdenum alloys

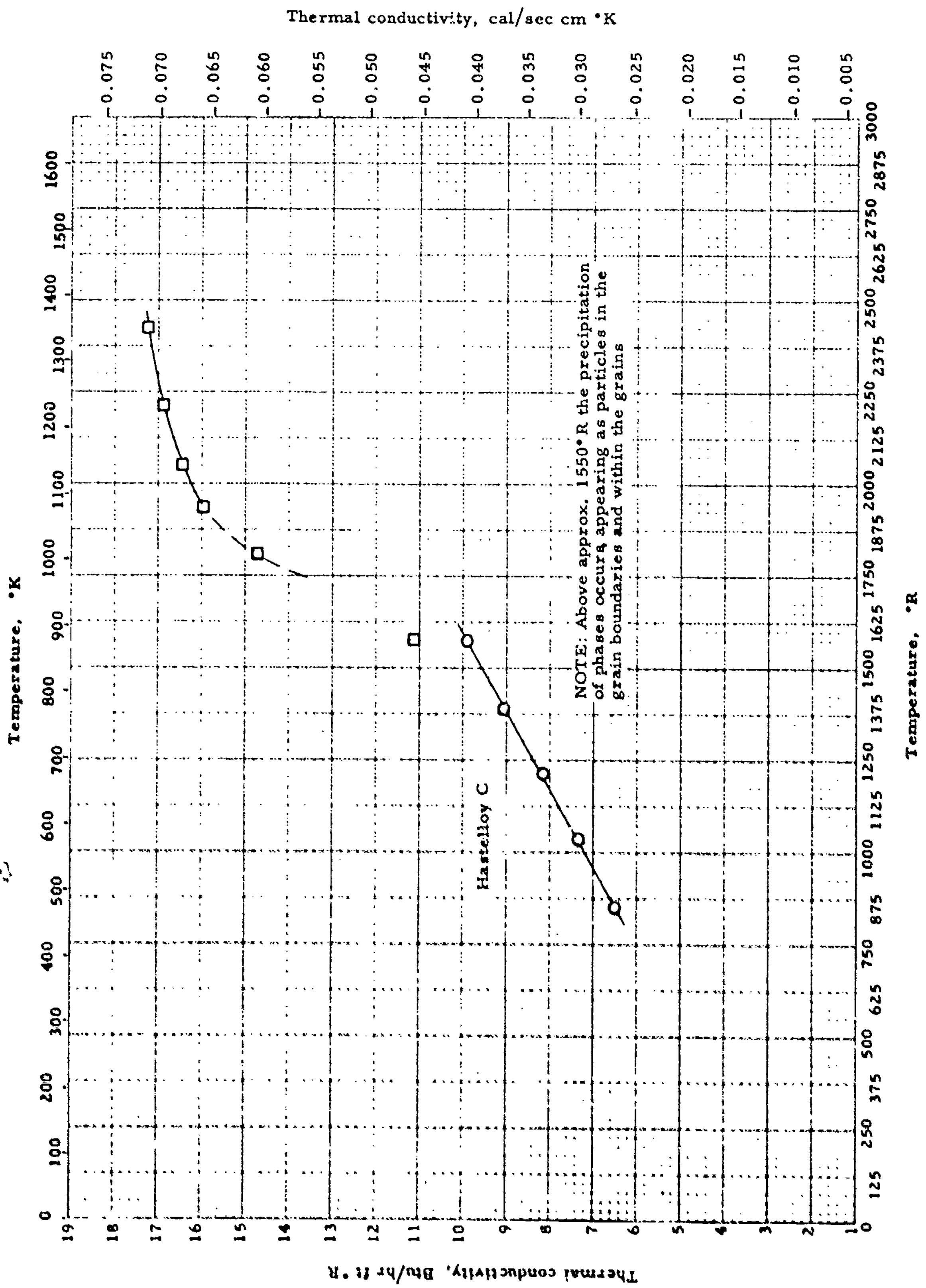


SPECIFIC HEAT -- NICKEL + MOLYBDENUM + X
(Hastelloys)

SPECIFIC HEAT -- NICKEL + MOLYBDENUM + X
(Hastelloys)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I. B., Hedge, J. C., et al.	58-4	1460-2660	Hastelloy B. Before test: 65.57% Ni; 23.78% Mo; 5.05% Fe; 0.020% C. After test: 65.55% Ni; 24.00% Mo; 4.96% Fe; 0.023% C. ρ = 585.5 lb_m/ft^3	Drop method; liq. calorimeter	
□	Ibid.	58-4	1460-2660	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.07% C. After test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W, 0.0687% C. ρ = 556.9 lb_m/ft^3	Same as above	

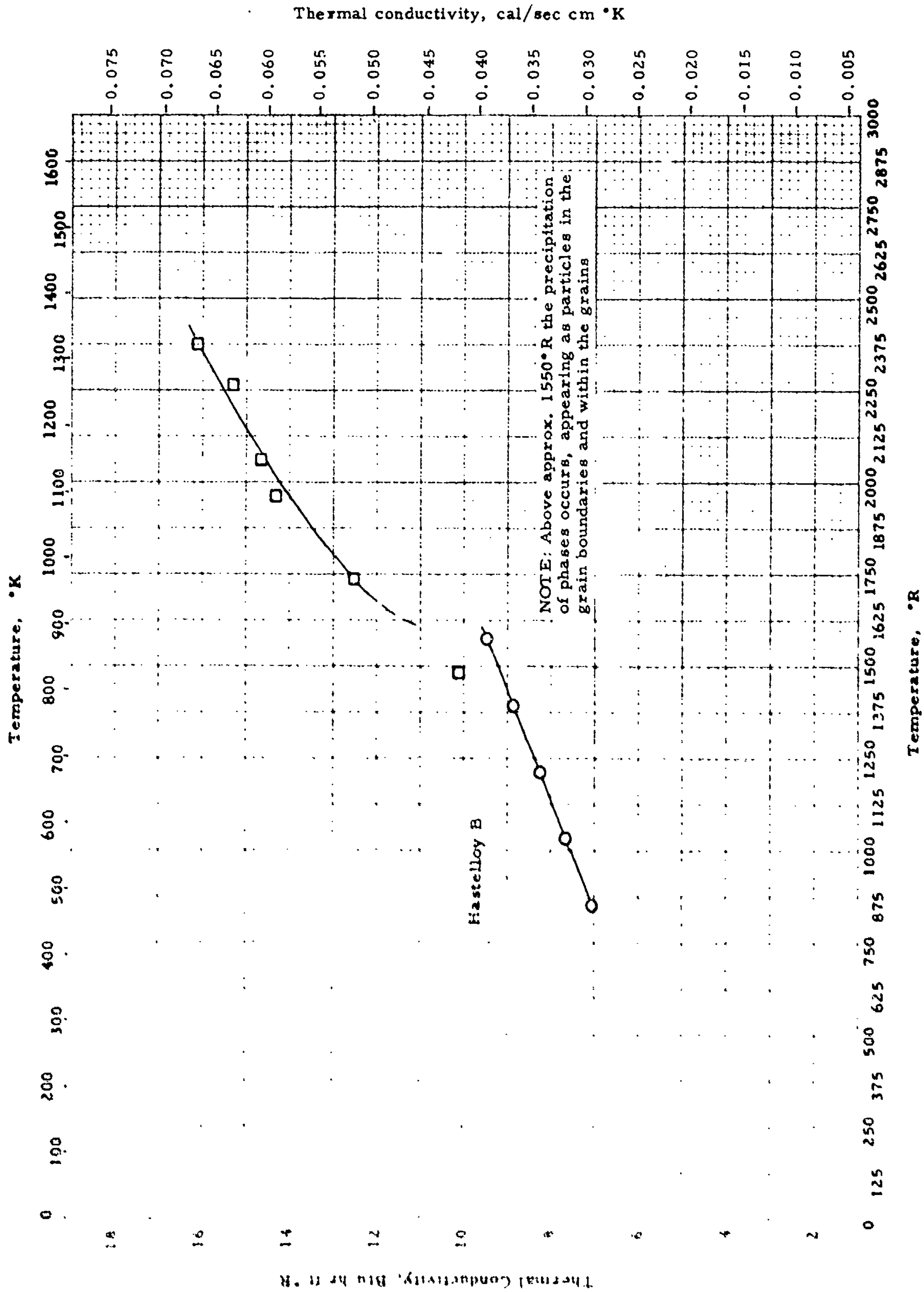


THERMAL CONDUCTIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + IRON + X
(Hastelloy C)

THERMAL CONDUCTIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + IRON + X
(Hastelloy C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeny, W. O.	50-14 also 47-14	852-1572	Hastelloy C (AMS-5530); 16.0-18.1% Mo; 15.5-17.5% Cr; 4.5-7.0% Fe; 3.75-5.25% W; 0.15% max. C; ρ = 558 lb_m/ft^3	Not given; probably comparative; rods	Data obtained at Batelle Memorial Institute
□	Fieldhouse, I. B., Hedge, J. C., et al	58-4	1577-2427	Hastelloy C; before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.070% C; after test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W; 0.068% C; ρ = 557 lb_m/ft^3	Single flat plate; boiling liquid calorimeter	Noted precipitation of Ni_4Mo phase as particles between and within the grains

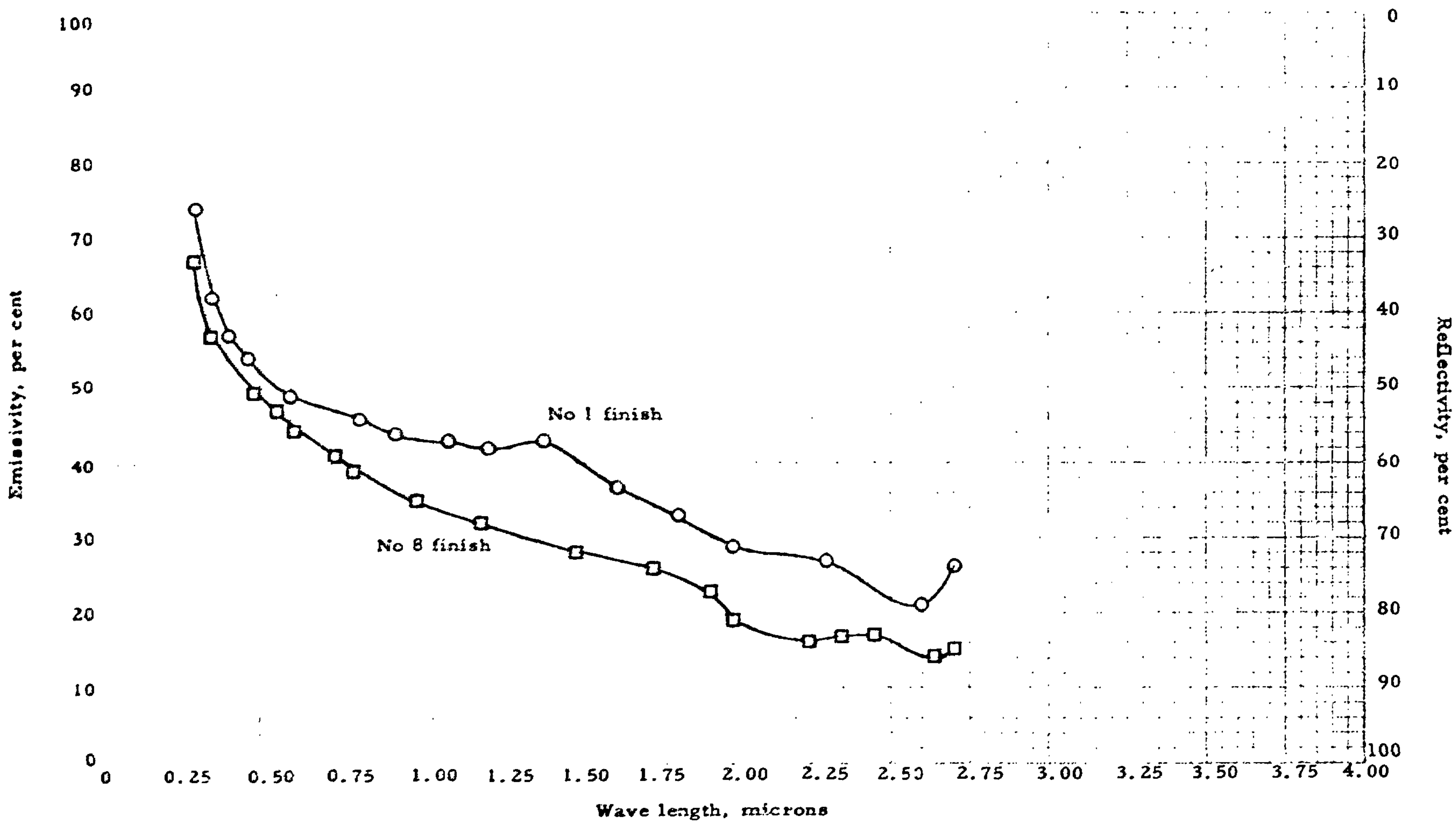


THERMAL CONDUCTIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

THERMAL CONDUCTIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeny, W. O.	50-14 also 47-14	352-1572	Hastelloy B; 26-30% Mo; 4-7% Fe; < 0.12% C; ρ = 577 lb_m/ft^3	Not given	Data obtained at B. M. I.
□	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	1480-2374	Hastelloy B: before test, 65.57% Ni; 23.78% Mo; 5.05% Fe; 0.020% C; after test, 65.55% Ni; 24.00% Mo; 4.96% Fe; 0.023% C; ρ = 585.5 lb_m/ft^3	Single flat plate boiling liquid calorimeter	Noted precipitation of Ni_4Mo phase as particles between and within the grains

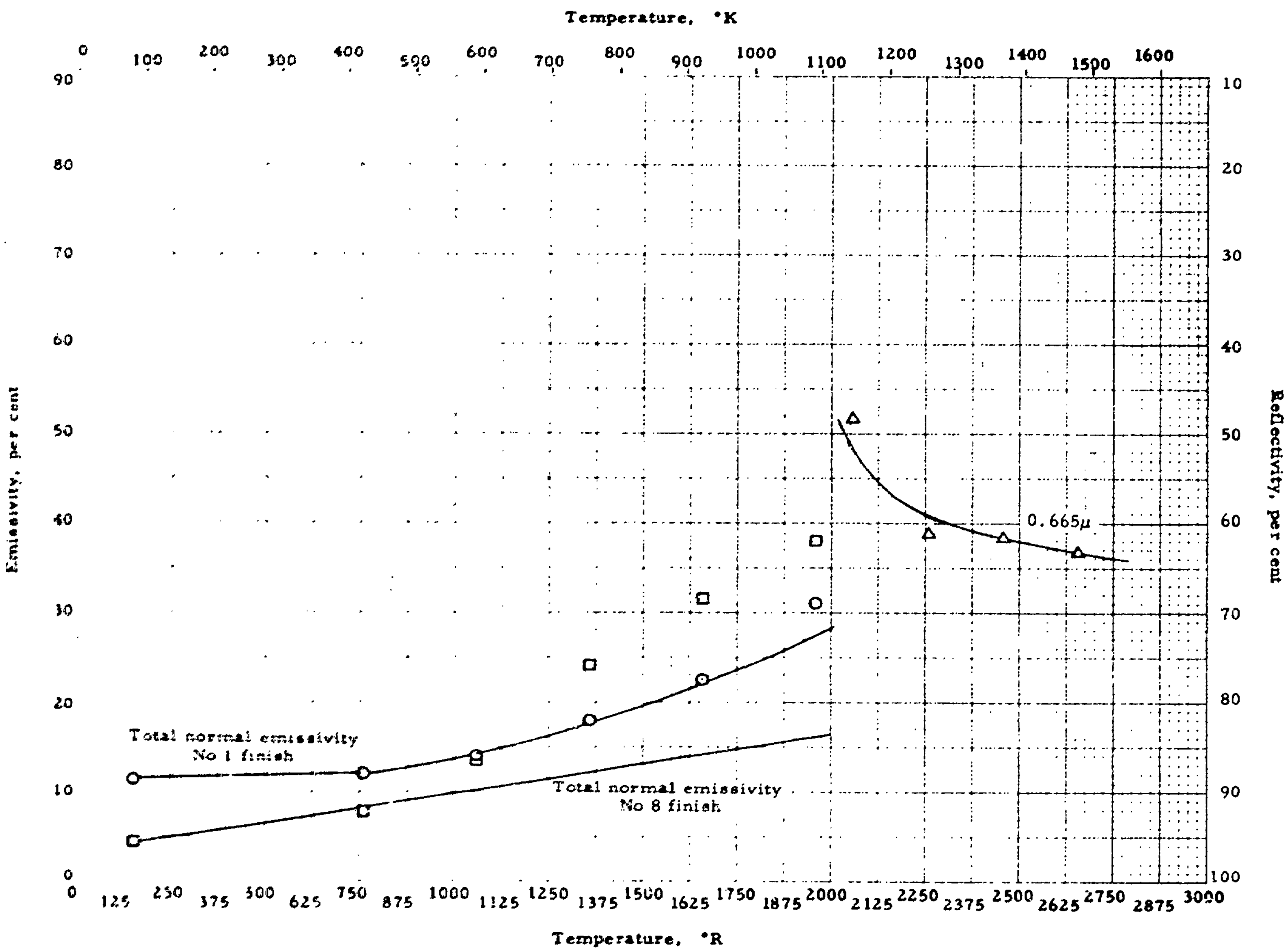


SPECTRAL EMISSIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

SPECTRAL EMISSIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H., et al.	57-8	Room	Hastelloy C; nominal analysis: 55% Ni; 17% Mo; 16.5% Cr; 5% ea. Fe, W: 1% ea. Si, Mn; 0.12% C	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 8, 2 microinch RMS

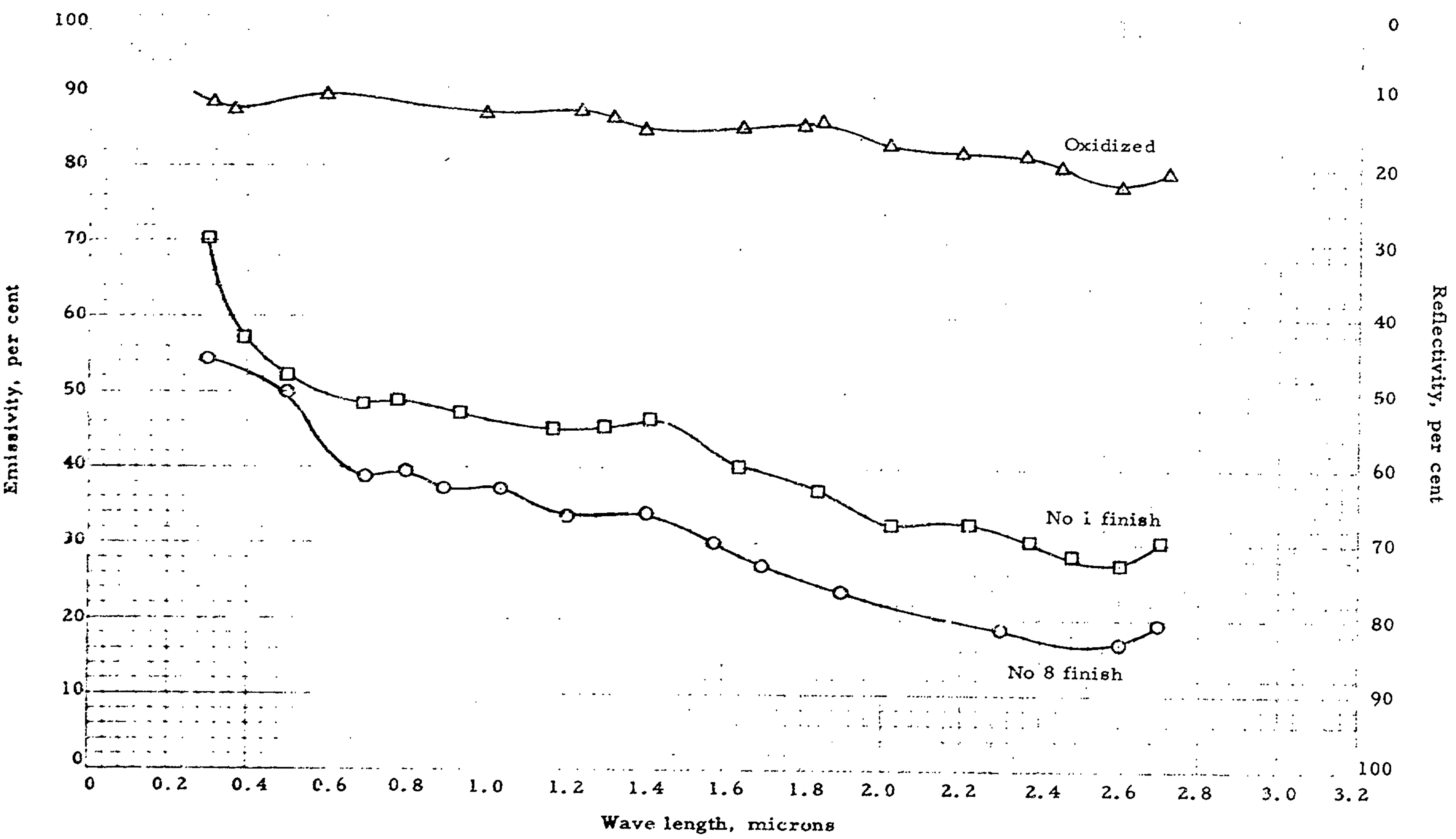


EMISSIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

EMISSIVITY -- NICKEL + MOLYBDENUM + CHROMIUM + X
(Hastelloy C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T., Olson, O.H., et al.	57-8	150-1960	Hastelloy C; nominal: 55% Ni; 17% Mo; 16.5% Cr; 5% ea. Fe, W; 1% ea. Si, Mn; 0.12% C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	150-1960	Same as above	Same as above	Finish No. 8, 2 microinch RMS
△	Ibid.	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative; surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Finish No. 1 and 8, 2-15 microinches

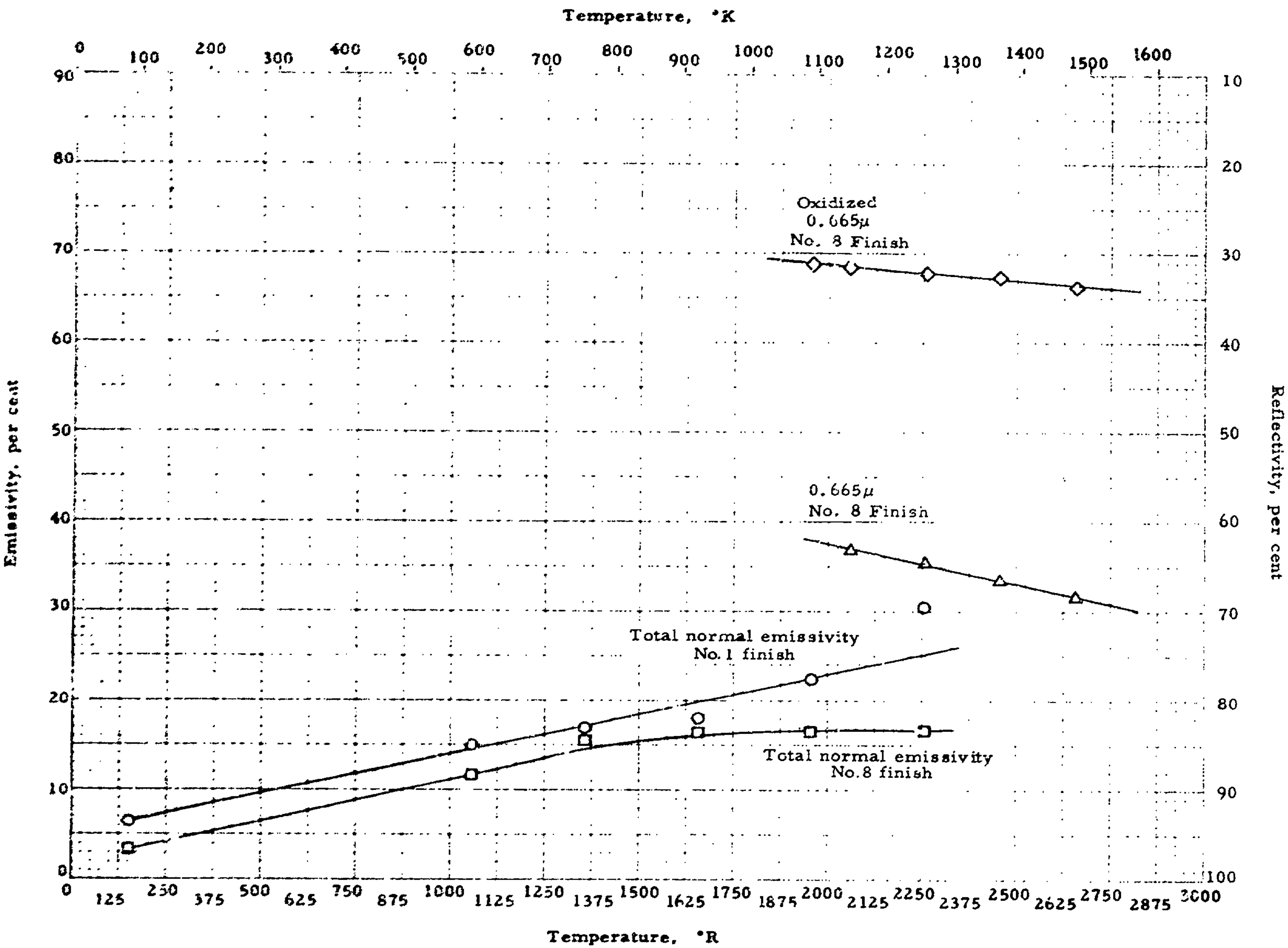


SPECTRAL EMISSIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

SPECTRAL EMISSIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H.T. Olson, O.H. et al.	57-8	Room	Hastelloy B, nominal: 65% Ni (Inc. Co), 28% Mo; 5% Fe; 1% Si; 1% Mn; 0.12% C	Spectral reflectivity at 9°: sample compared with $MgCO_3$ standard in MgO integrating sphere, quartz lens, PbS detector	Finish No. 8, 2 microinch RMS
□	Ibid.	57-8	Room	Same as above	Same as above	Finish No. 1, 15 microinch RMS
△	Olson, O.H., and Morris, J.C.	58-1	Room	Same as above	Same as above	Oxidized 30 min. at red heat in air

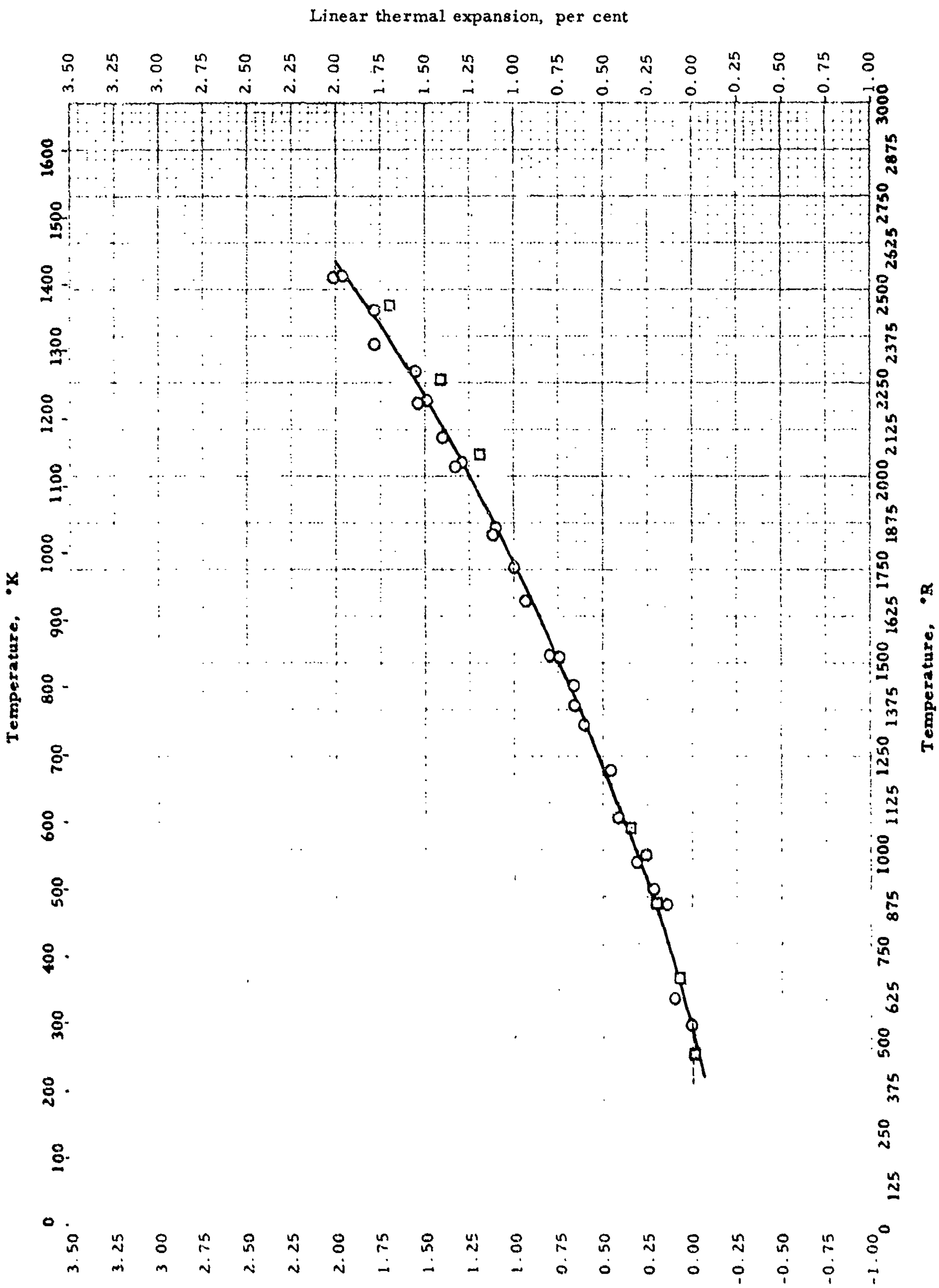


EMISSIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

EMISSIVITY -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H., et al.	57-8	150-2260	Hastelloy B; nominal: 65% Ni; 28% Mo; 5% Fe; 1% Si, 1% Mn, 0.12% C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Finish No. 1, 15 microinch RMS
□	Ibid.	57-8	150-2260	Same as above	Same as above	Finish No. 8, 2 microinch RMS
△	Ibid	57-8	1960-2660	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Finish No. 8, 2 microinch RMS
<	Ibid.	57-8	1960-2650	Same as above	Same as above	Finish No. 8, 2 microinch RMS, oxidized 30 min. at red heat in air

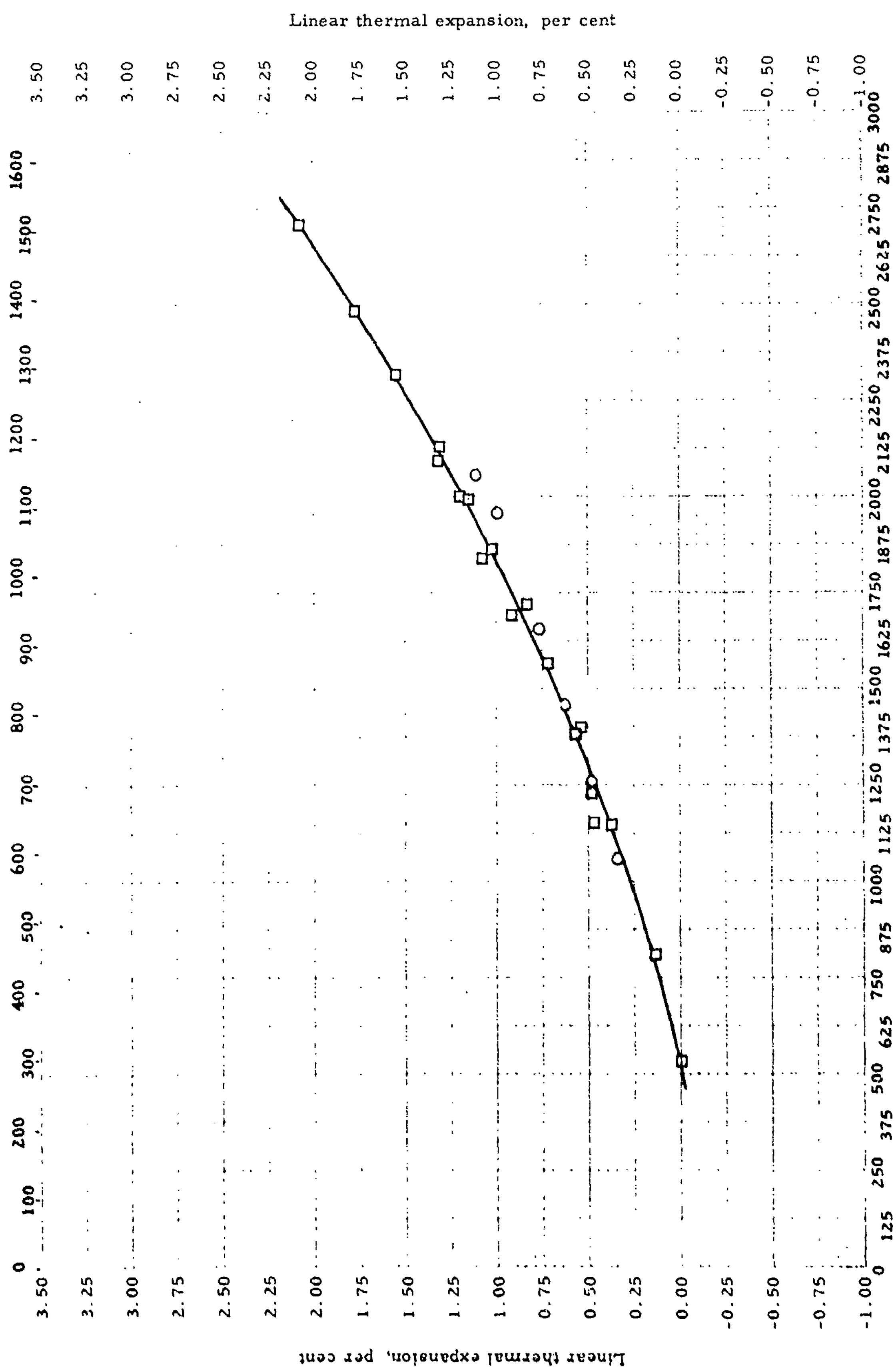


LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + X
(Hastelloy C)

LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + X (Hastelloy C)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I.B., Hedge, J.C. et al.	58-4	540-2531	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.070% C. After test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W; 0.068% C. ρ = 556.9 lb_m/ft^3	Telemicroscopes sighting on sample	
□	Sweeny, W.O.	50-14	460-2460	Hastelloy C (AMS-5530). Nominal: 16.0-18.0% Mo; 15.5-17.5% Cr; 4.5-7.0% Fe; 3.75-5.25% W; 0.15% C max. ρ = 558 lb_m/ft^3	Not given	Data from Union Carbide and Carbon Research Labs., Inc.

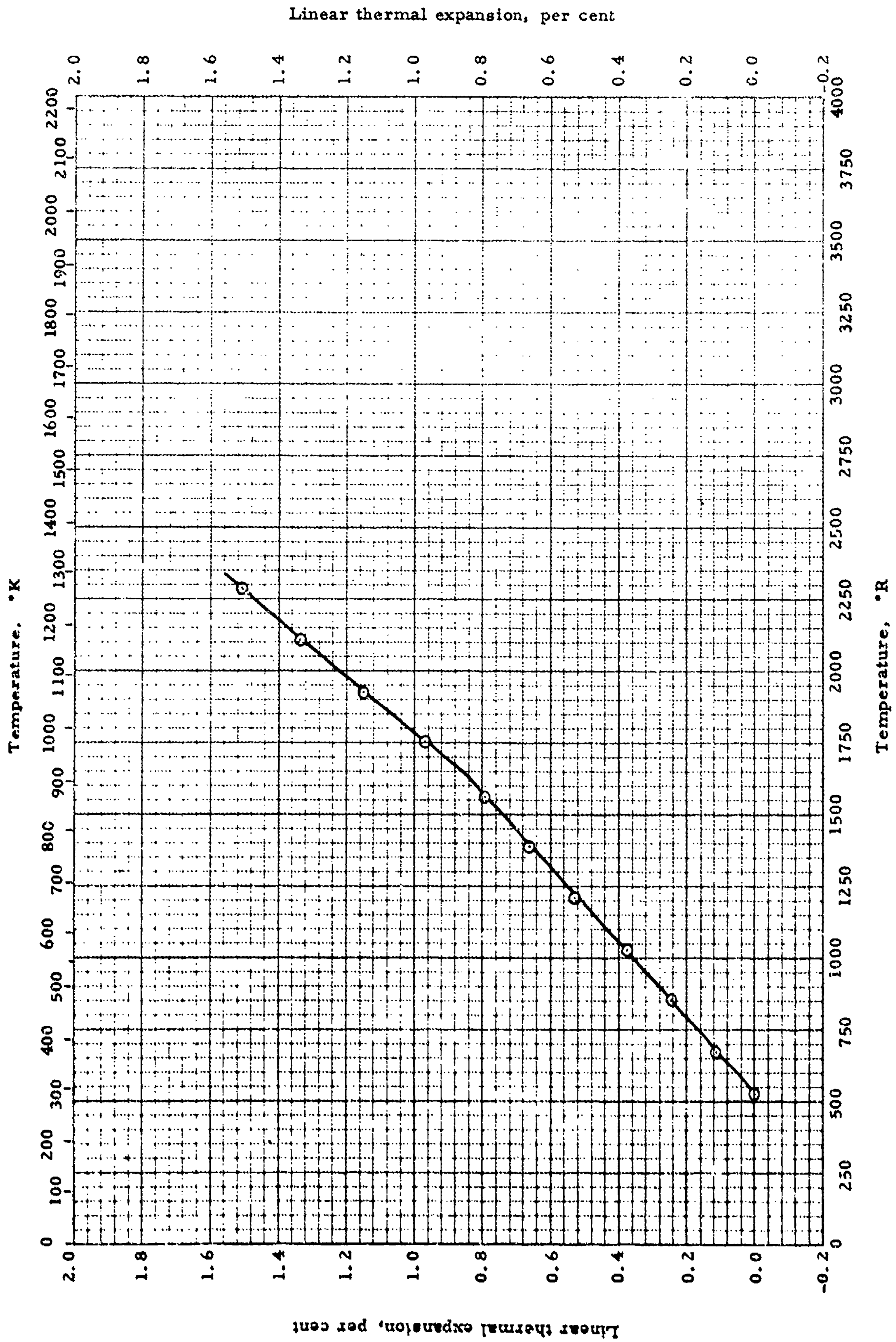


LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + IRON + X
(Hastelloy B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeny, W.O.	50-14	1060-2060	Hastelloy Alloy B. Nominal: 26.0 - 30.0% Mo; 4.0 - 7.0% Fe; 0.12% C max. ρ = 577 lb_m/ft^3	Not given	Data from Union Carbide and Carbon Research Labs., Inc.
□	Fieldhouse, I.B., Hedge, J.C. et al.	58-4	540-2705	Hastelloy B. Before test: 65.57% Ni; 23.78% Mo; 5.05% Fe; 0.020% C After test: 65.55% Ni; 24.00% Mo; 4.96% Fe; 0.023% C. ρ = 585.5 lb_m/ft^3	Telemicroscopes sighting on sample	



LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + X

LINEAR THERMAL EXPANSION -- NICKEL + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Fulkerson, S. D.	57-159	672-2290	INOR-8: 16.90% Mo; 6.86% Cu; 4.21% Fe; 0.84% Mn; 0.23% Si; 0.14% C	Sapphire dilatometer	Auth. est. precision 99%

PROPERTIES OF NICKEL + COBALT + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density, Nimonic 100 . .	500 lb_m/ft^3	8.0 g/cm^3
Melting Point, Nimonic 100	2920 °R	1620 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

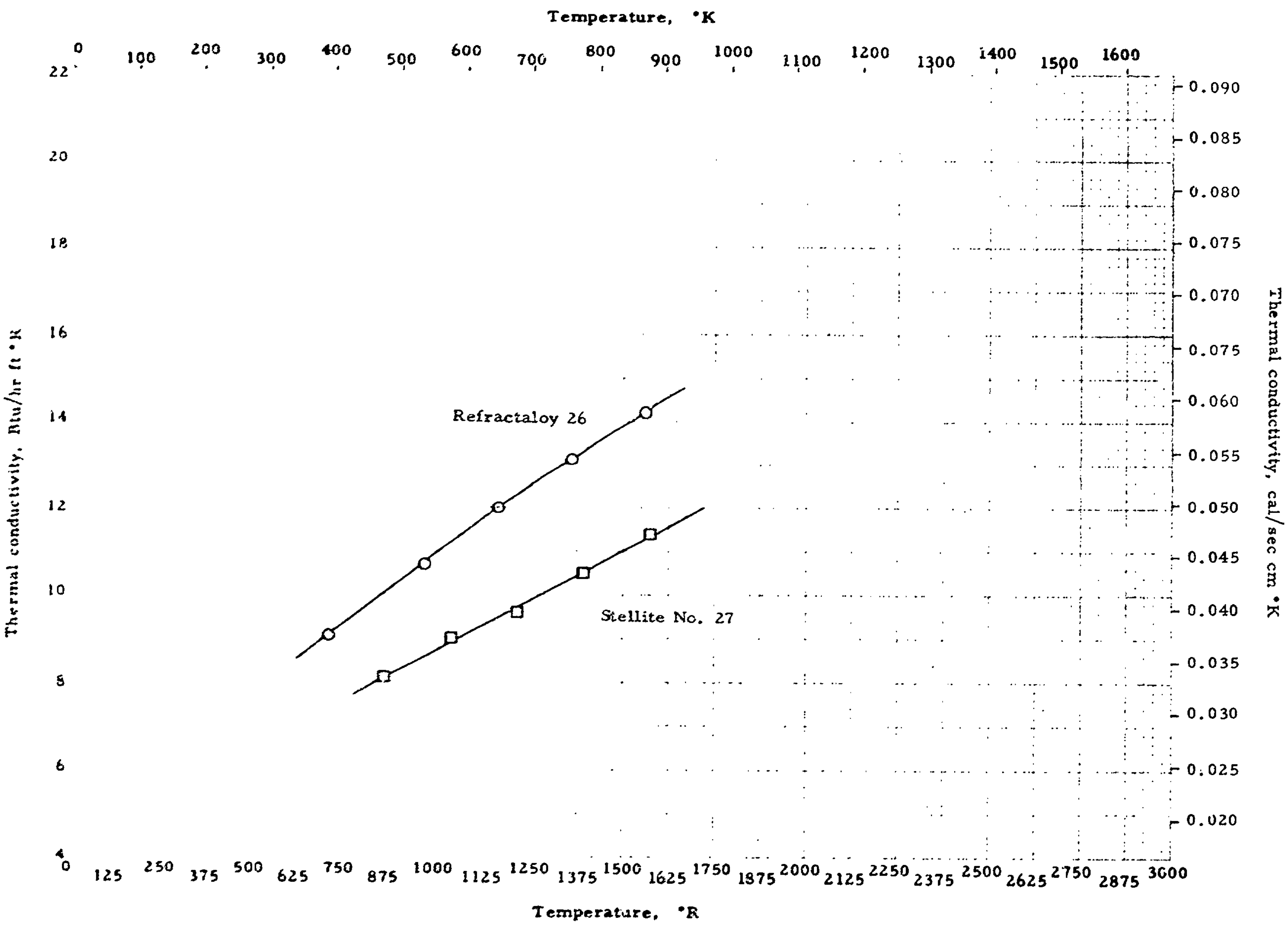
REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	502	8.04
	□	545.2	8.734
	△	538.7	8.629
	◇	554.1	8.875
	▽	536.3	8.590
	⬡	513	8.21
Melting Point:		°R	°K
	○	2912 ± 63	1618 ± 35
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF NICKEL + COBALT + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Anon.	56-117	Room 2849-2975	Nimonic 100: 18-22% Co; 10-12% Cr; 4.5-5.5% Mo; 4-6% Al; < 2% Fe; 1-2% Ti; < 0.5% Si; < 0.30% C	ρ: not given MP: not given	
□	Cornelius, H., Bungardt, W. and Bollenrath, F.	47-8	528	DVL 321a (German Designation): 34.1% Ni; 25.4% Co; 14.6% Cr; 13.8% Fe; 5.0% Mo; 4.75% W; 1.3% Ta; 0.54% Mn; 0.45% Si; 0.04% C;	ρ: not given	
△	Ibid.	47-8	528	DVL 321i (German Designation): 34.2% Ni; 25.5% Co; 14.8% Cr; 13.7% Fe; 5.2% Mo; 4.5% W; 1.08% Ti; 0.62% Mn; 0.40% Si; 0.04% C	ρ: Same as above	
◇	Ibid.	47-8	528	DVL 325a (German Designation): 34.3% Ni; 25.1% Co; 14.9% Cr; 4.9% Mo; 4.88% Ta; 4.54% W; 0.53% Mn; 0.49% Si; 0.04% C	ρ: Same as above	
▽	Ibid.	47-8	528	DVL 32 (German Designation): 35.2% Ni; 24.5% Co; 15. % Fe; 14.6% Cr; 4.7% W; 4.46% Mo; 0.71% Mn; 0.44% Si; 0.03% C	ρ: Same as above	
⬡	Sweeny, W. O	50-14	Room	Haynes Stellite Alloy No. 27: 30.0% Co min; 23.0-29.0% Cr; 5.0-7.0% Mo; 2.0% Fe max; 0.35-0.50% C (NR-60, AMS-5378)	ρ: Not given	

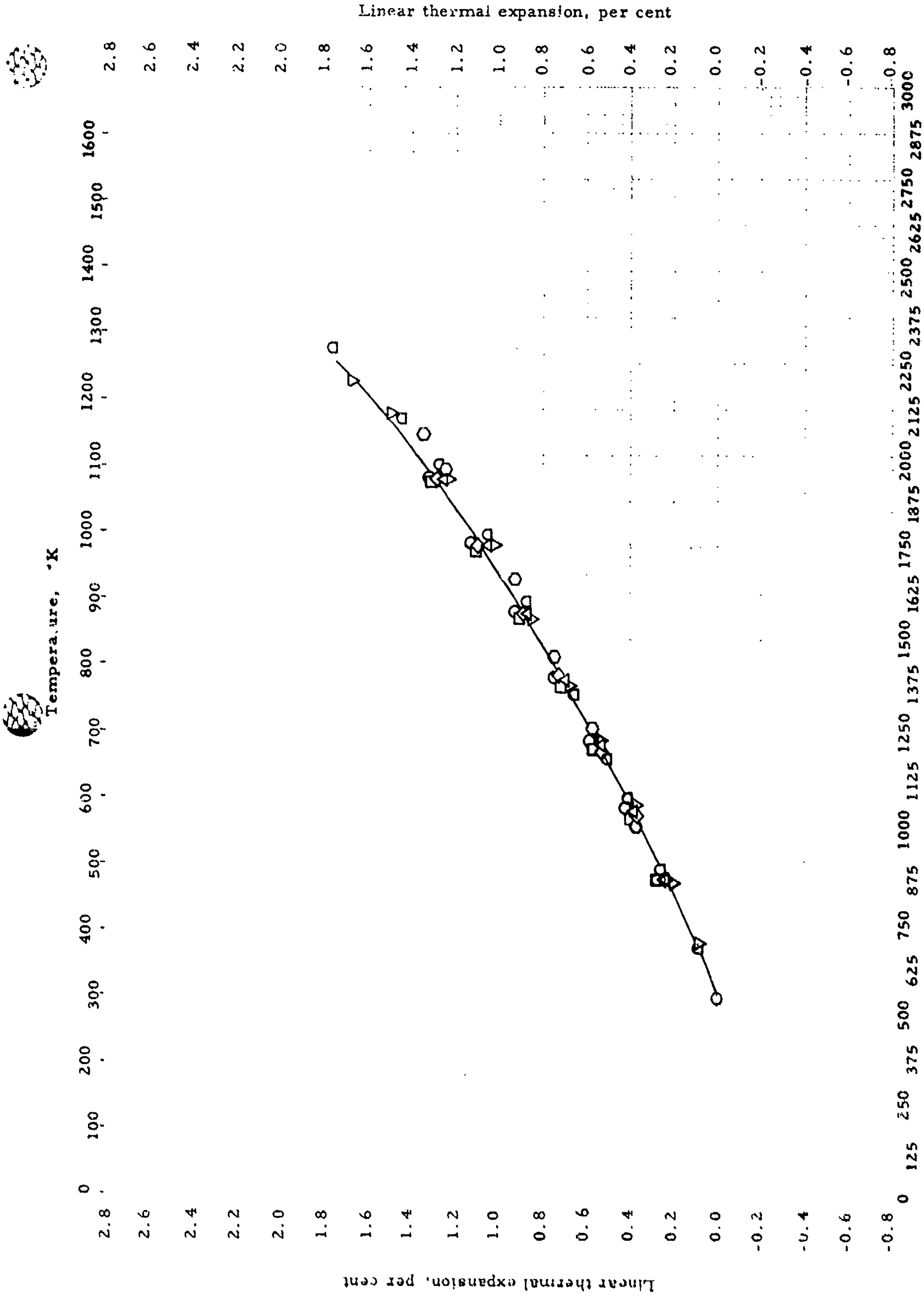


THERMAL CONDUCTIVITY -- NICKEL + COBALT + CHROMIUM + X

THERMAL CONDUCTIVITY -- NICKEL + COBALT + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Evans Jr., J. E.	51-16	695-1560	Refractaloy 26: 37.0% Ni; 20.0% Co; 18.67% Fe (by difference); 18.0% Cr; 3.0% ea. Mo, Ti; 0.3% Al; 0.03% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%
□	Sweeny, W. O.	50-14 also 47-14	352-1572	Stellite No. 27 (AMS-5378, NRDC-60): > 30.0% Co; 23.0-29.0% Cr; 5.0-7.0% Mo; <2.0% Fe; 0.35-0.50% C; ρ = 513 lb_m/ft^3	Not given	Results obtained at G.E., Co.

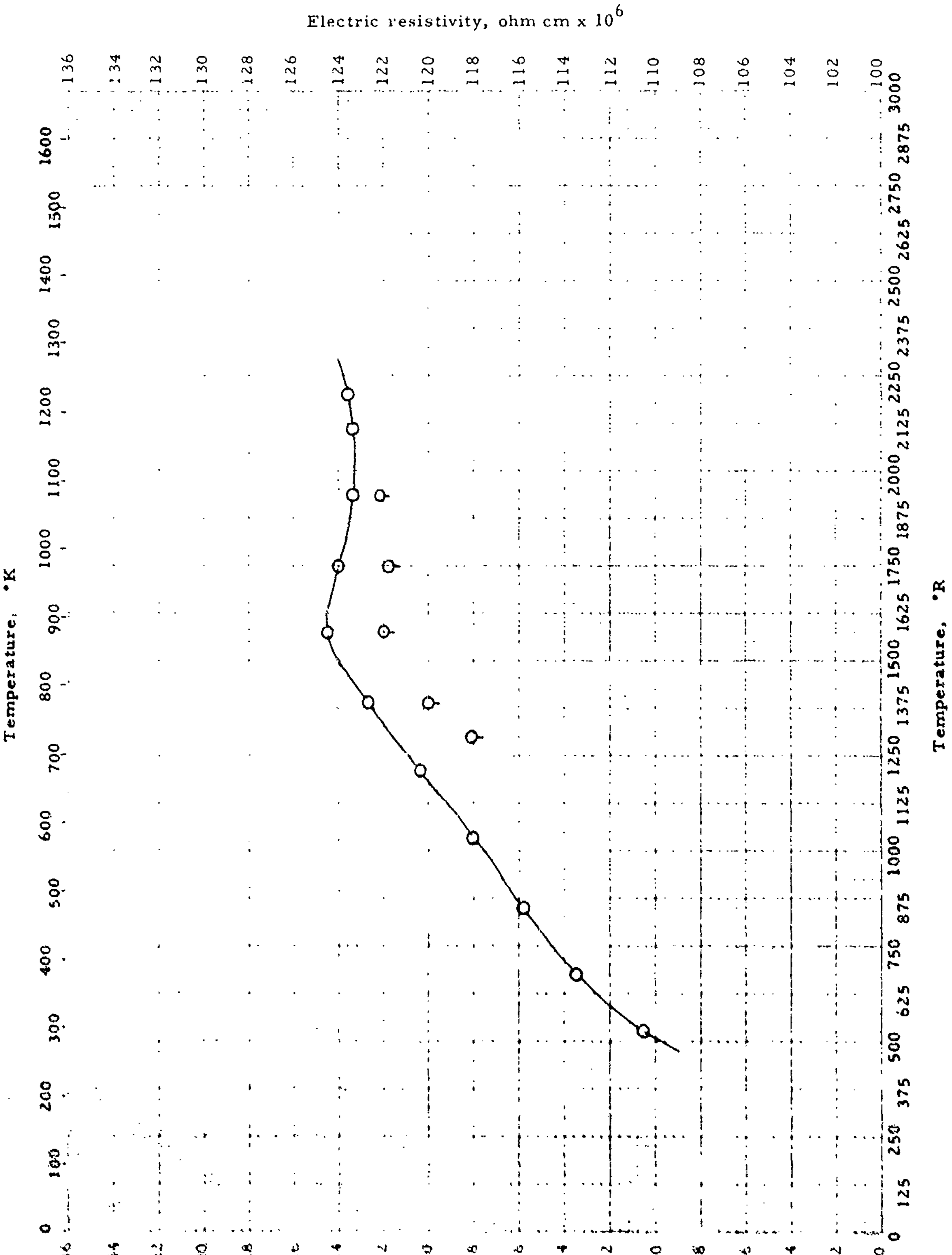


LINEAR THERMAL EXPANSION -- NICKEL + COBALT + CHROMIUM + X

LINEAR THERMAL EXPANSION -- NICKEL + COBALT + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cornelius, H., Bungardt, W., and Bollenrath, F.	47-8	852-1932	DVL 321 a (Ger. Desig.): 34.1% Ni; 25.4% Co; 14.6% Cr; 13.8% Fe; 5.0% Mo; 4.75% W; 1.35% Ta; 0.54% Mn; 0.45% Si; 0.04% C; ρ = 545.2 lb_m/ft^3	Dilatometer	Rolled
□	Ibid.	47-8	852-1932	DVL 321 i (Ger. Desig.): 34.2% Ni; 25.5% Co; 14.6% Cr; 13.7% Fe; 5.2% Mo; 4.5% W; 1.08% Ti; 0.62% Mn; 0.40% Si; 0.04% C; ρ = 538.7 lb_m/ft^3	Same as above	Same as above
△	Ibid.	47-8	852-1932	DVL 325 a (Ger. Desig.): 34.3% Ni; 25.1% Co; 14.9% Cr; 4.[illegible]% Mo; 4.88% Ta; 4.54% W; 0.53% Mn; 0.49% Si; 0.04% C; ρ = 554.1 lb_m/ft^3	Same as above	Same as above
◇	Ibid.	47-8	852-1932	DVL 32 (Ger. Desig.): 35.2% Ni; 24.5% Co; 15.4% Fe; 14.6% Cr; 4.7% W; 4.46% Mo; 0.71% Mn; 0.44% Si; 0.03% C; ρ = 536.3 lb_m/ft^3	Same as above	Same as above
▽	Brace, P. H.	42-3	[illegible]28-2202	46.1% Ni; 24.86% Co; 18.74% Cr; 7.02% Fe; 2.19% Ti	Not given	
○	Sweeny, W. O.	50-14	1960-2060	Haynes Stellite (AMS-5378) Alloy No. 27 NR-60 Nominal: 30.0% Co min.; 23.0 - 29.0% Cr; 5.0 - 7.0% Mo; 2.0% Fe max; 0.35 - 0.50% C. ρ = 513 lb_m/ft^3	Not given	
◌	Anon.	56-117	672-2242	Nimonic 100 Nominal: 18 - 22% Co; 10 - 12% Cr. 4.5 - 5.5% Mo; 4 - 6% Al; [illegible] 2% Fe, 1 - 2% Ti; < 0.5% Si; < 0.3% C. ρ = 502 lb_m/ft^3	Not given	

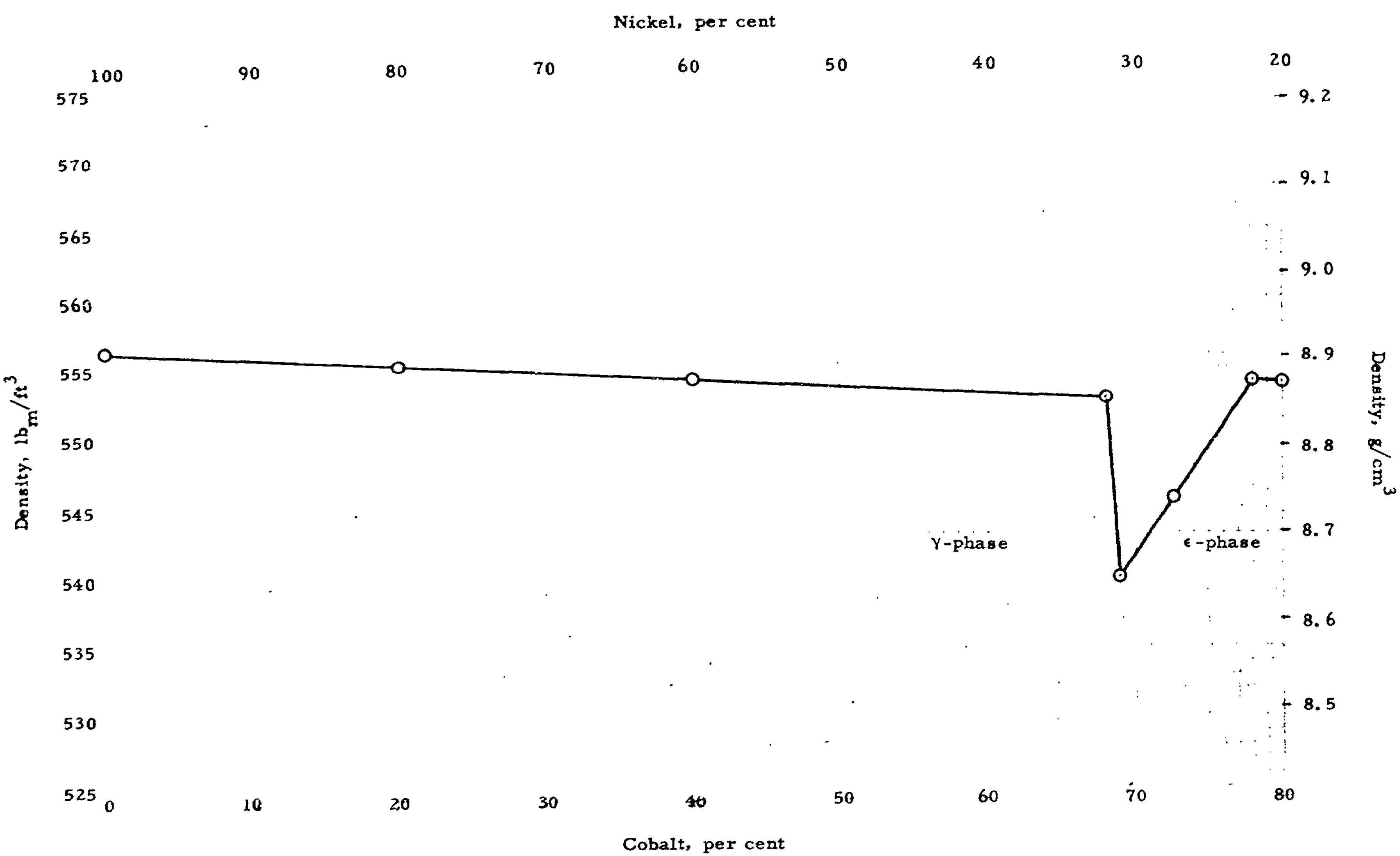


ELECTRIC RESISTIVITY -- NICKEL + COBALT + CHROMIUM + IRON + X

ELECTRIC RESISTIVITY -- NICKEL + COBALT + CHROMIUM + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Brace, H. P.	42-3	528-2202	46.1% Ni; 24.86% Co; 18.74% Cr, 7.02% Fe, 2.19% Ti	Not given	First heating at 12°C/min. Auth. reports same values offer the following heat treatment during test: heated to 950°C in 75 min. held 1 hr. at 950°C, cooled to 450°C in 4 min., heated to 600°C in 7 min. and held 16 hr. at 600°C. Cooling during test at 2.5°C/min.
O	Ibid.	42-3	1112-2202	Same as above	Same as above	First cooling at 75°C/min. after the above mentioned first heating to 950°C in 75 min.

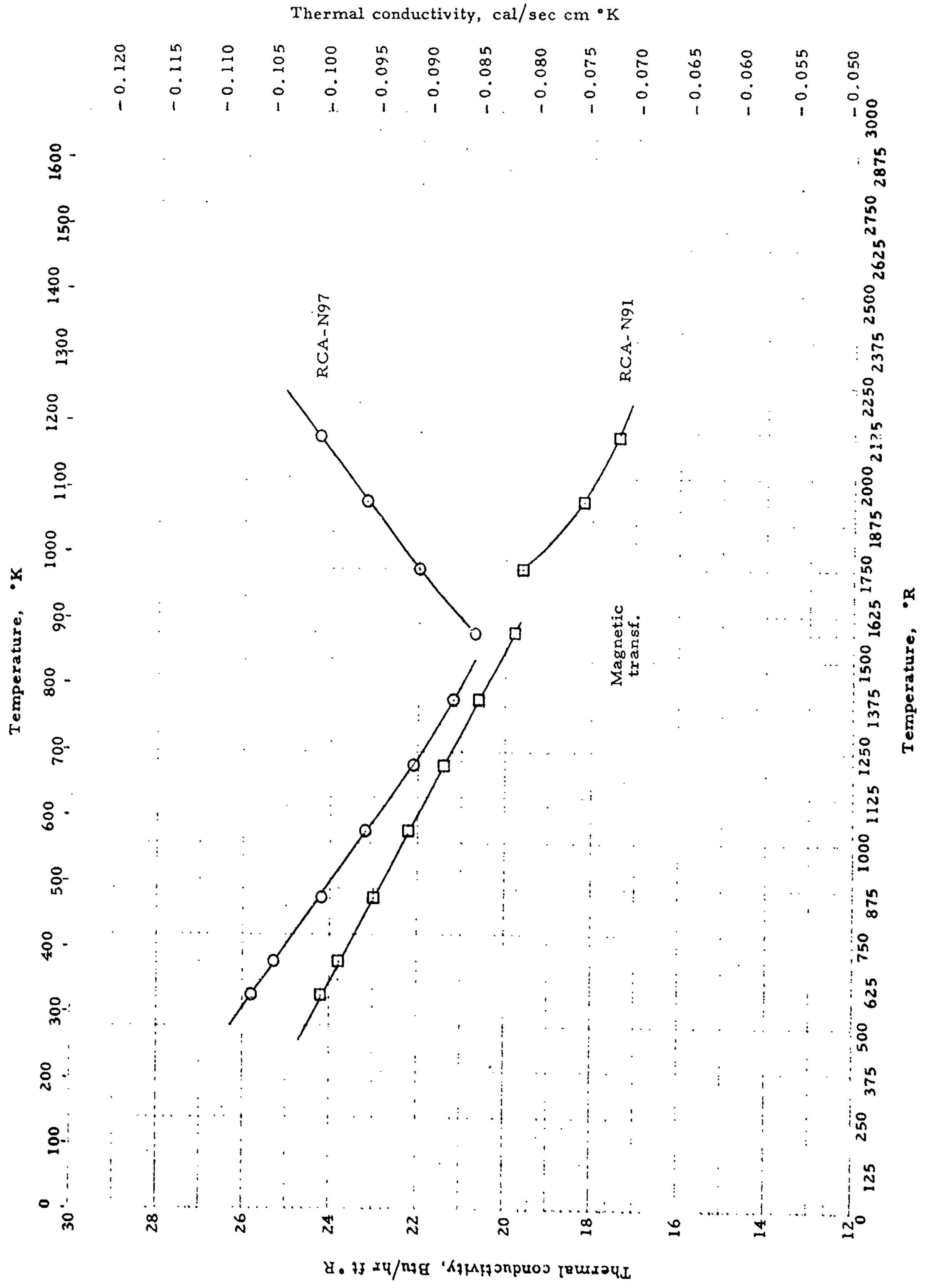


DENSITY -- NICKEL + COBALT

DENSITY -- NICKEL + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Yamamoto, M.	50-35	Room	0 - 60% Co; made from 99.92% pure Ni and 99.8 % pure Co	Weight in air and in distilled water	Melted in alumina tube. Electrolytic Ni contained 0.037% Fe; 0.030% Co; 0.023% As; 0.020% Cu; 0.01% C; 0.009% P; 0.001% ea. Si, Mn; no S. Electrolytic Co contained 0.117% Fe; 0.06% C; 0.02% ea. As, Cu; 0.013% P; 0.001% ea. Si, Mn; no Ni, S. Forged, annealed, rolled, annealed, machined to size, annealed 2 hrs at 1100° C



THERMAL CONDUCTIVITY -- NICKEL + COBALT + X

THERMAL CONDUCTIVITY -- NICKEL + COBALT + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Silverman, L.	53-2	582-2112	RCA-N97: 78.1% Ni; 21.6% Co; 0.185% Mn; 0.115% C; 0.01% Mg	Comparative; rods (Pb primary standard; "Advance" working standard)	
□	Ibid.	53-2	582-2112	RCA-N91: 59.5% Ni; 40.0% Co; 0.19% Si; 0.175% Mn; 0.132% C; 0.01% Mg	Same as above	

PROPERTIES OF NICKEL + IRON + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 58% Ni	509 lb_m/ft^3	8.15 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

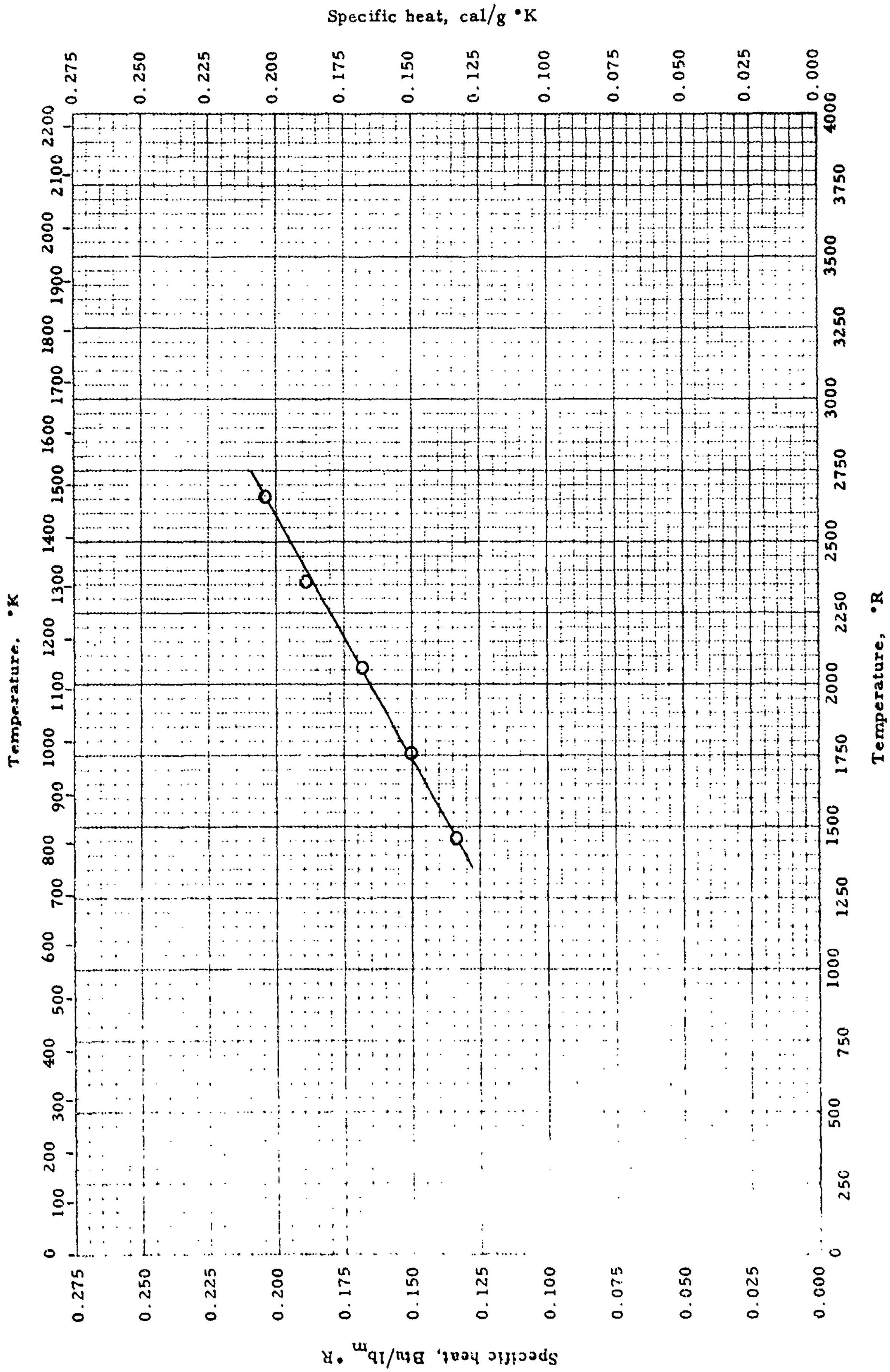
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	508.9	8.152
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF NICKEL + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	Room	60-15 Cr (ASTM B83-46): 57.70% Ni; 23.92% Fe; 15.73% Cr; 1.14% Si; 0.052% C; 0.04% Mo	ρ: not given	

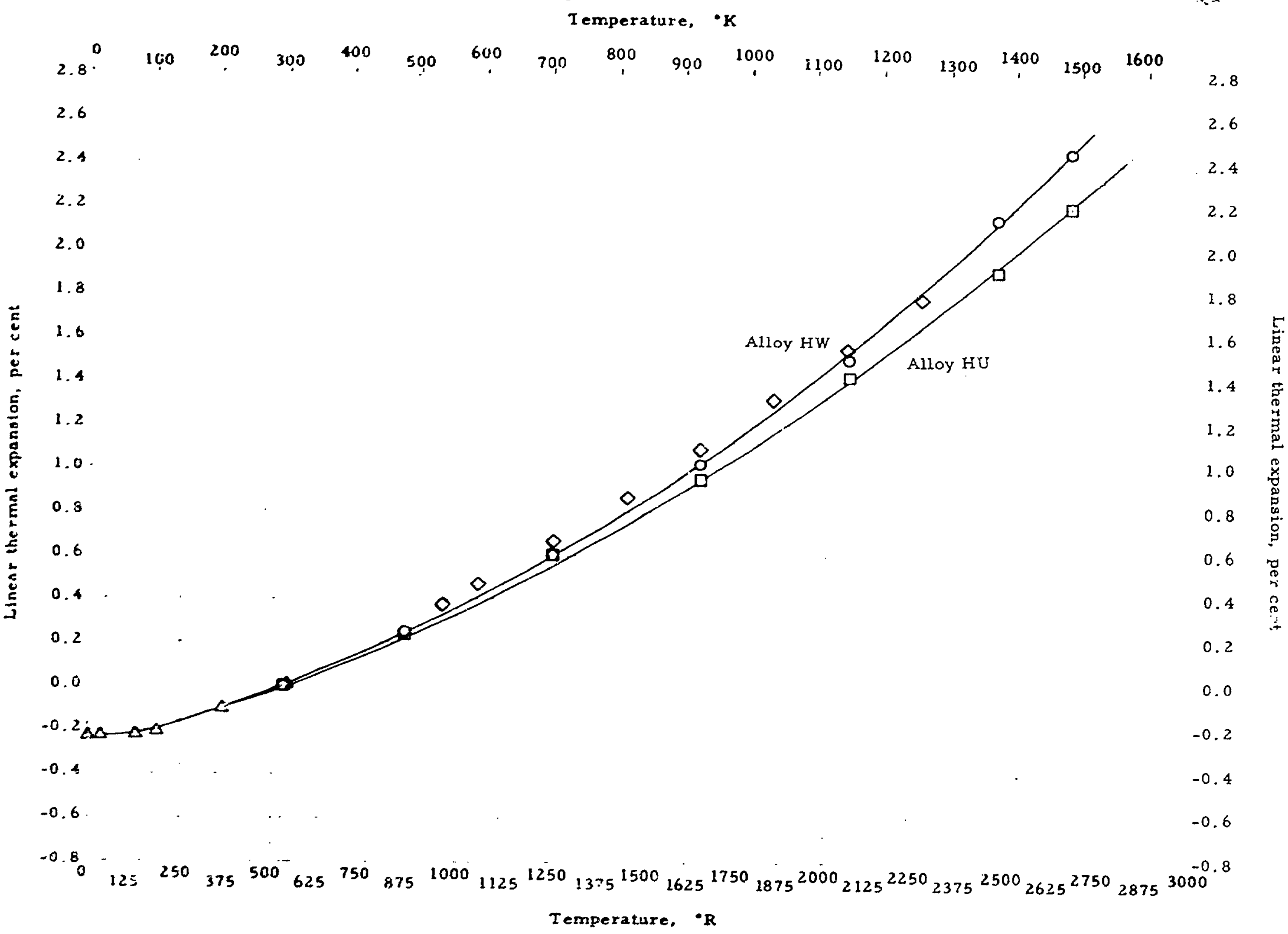


SPECIFIC HEAT -- NICKEL + IRON + CHROMIUM + X

SPECIFIC HEAT -- NICKEL + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	1460-2660	ASTMB83-46. Before test: 57.7% Ni; 23.92% Fe; 15.73% Cr; 1.14% Si; 0.052% C; 0.04% Mo; After test: 57.76% Ni; 23.91% Fe; 15.80% Cr; 1.33% Si; 0.05% C; 0.03% Mo; $\rho = 509\ lb_m/ft^3$	Drop method: liquid calorimeter	

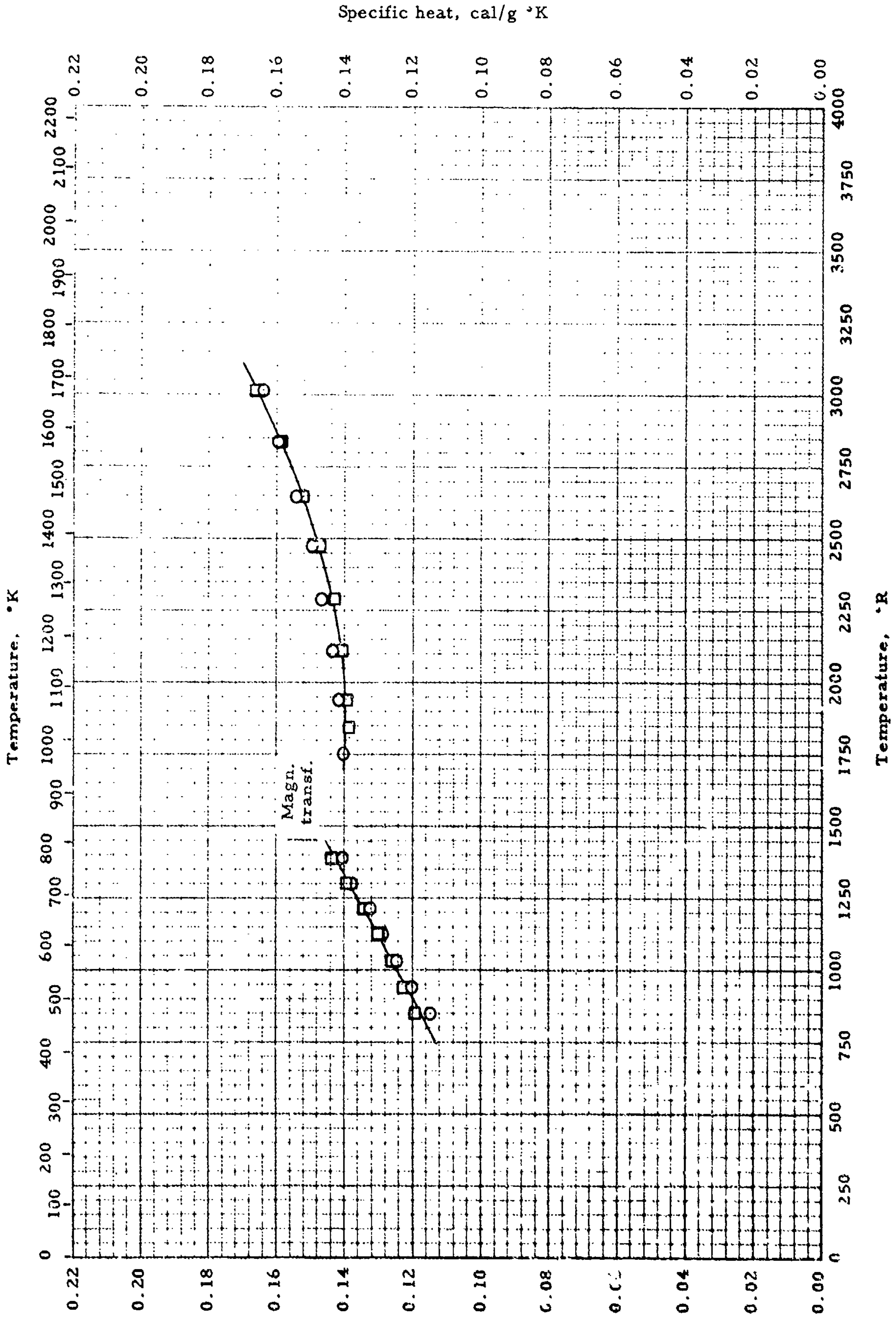


LINEAR THERMAL EXPANSION -- NICKEL + IRON + CHROMIUM + X

LINEAR THERMAL EXPANSION -- NICKEL + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Apblett, W. R. and Pellini, W. S.	51-[illegible]	[illegible]28-2660	Alloy HW; 40.0% Ni; 39.3% Fe; 17.2% Cr; 1.52% Si; 0.67% Mn; 0.66% C; 0.27% Co; 0.22% Nb; 0.12% Mo; 0.039% N_2	Strain gages on channel-shaped clip fastened to pins welded on sample	Heated at 200°F/sec.
□	Ibid.	51-[illegible]	528-2660	Alloy HU; 60.3% Ni; 19.1% Fe; 17.0% Cr; 1.43% Si; 1.13% Mn; 0.48% C; 0.23% Co; 0.22% Nb; 0.08% Mo; 0.041% N_2	Same as above	Same as above
△	Laquer, H. L.	52-39	0-540	Contracid; nominal: 60% Ni; 17.4% Fe, 15% Cr, 7% Mo; 0.6% Be	Interferometer	Integrated values of expansion coefficients measured by Altman, Rubin, and Johnston 1949-1951 (unpublished)
◇	Miller, H. A. et al.	53-127	960-2260	Nominal: 44.75% Ni; 25.6% Fe; 22.5% Cr; 6.25% Si; [illegible].00% Mn; <0.125% C	Recording dilatometer at 0.05 μ Hg vacuum	50% GE-62 Braze; 50% AISI 310 arc melted, cast, heated at 2260°R for 24 hr. in vacuum. Data average of heating and cooling cycles at 5.5 °F/min

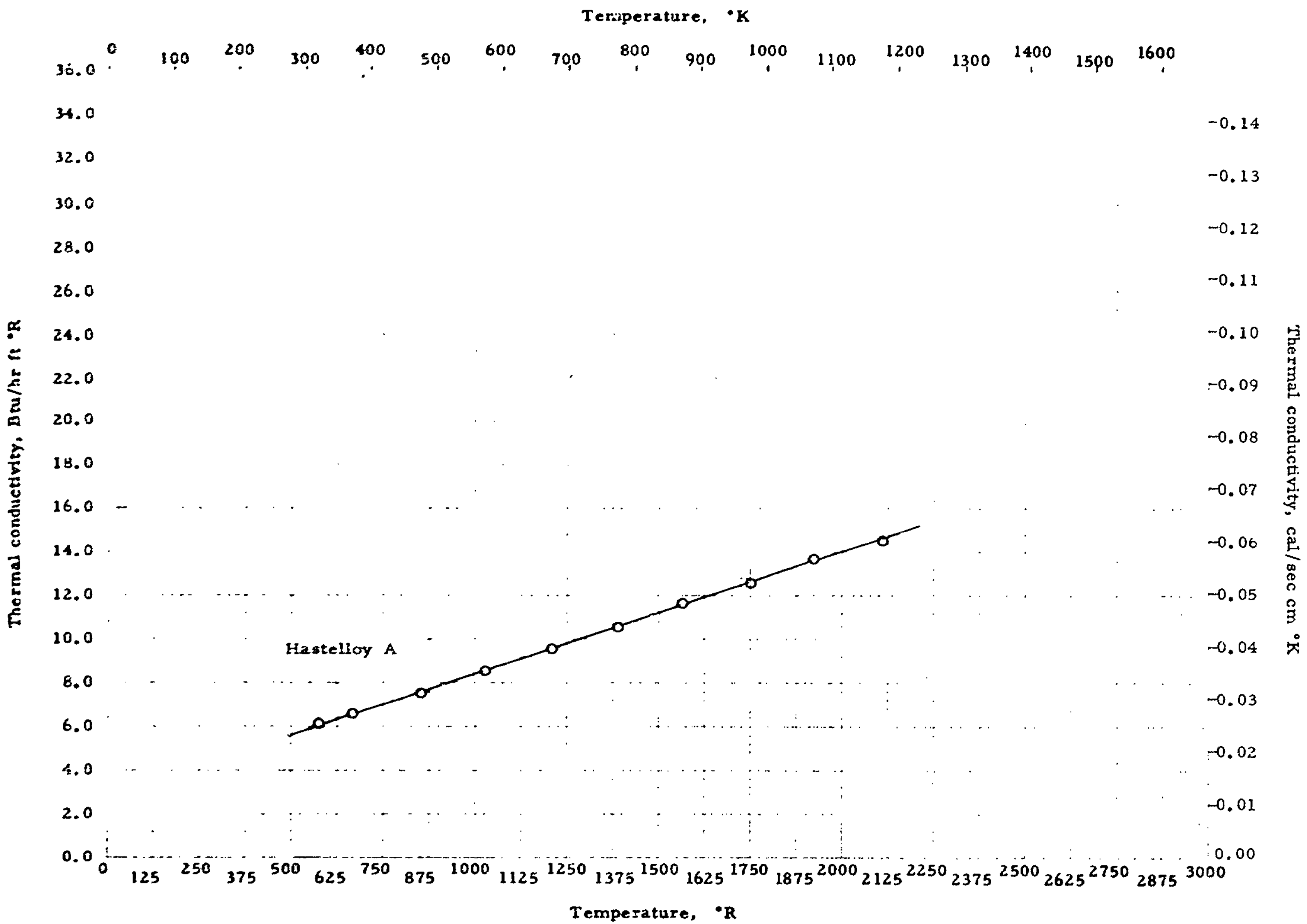


SPECIFIC HEAT -- NICKEL + IRON

SPECIFIC HEAT -- NICKEL + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Zuithoff, A. C.	40-7	852-3012	79.3% Ni; 20.7% Fe	Drop method	
□	Ibid.	40-7	852-3012	69.76% Ni; 30.24% Fe	Same as above	

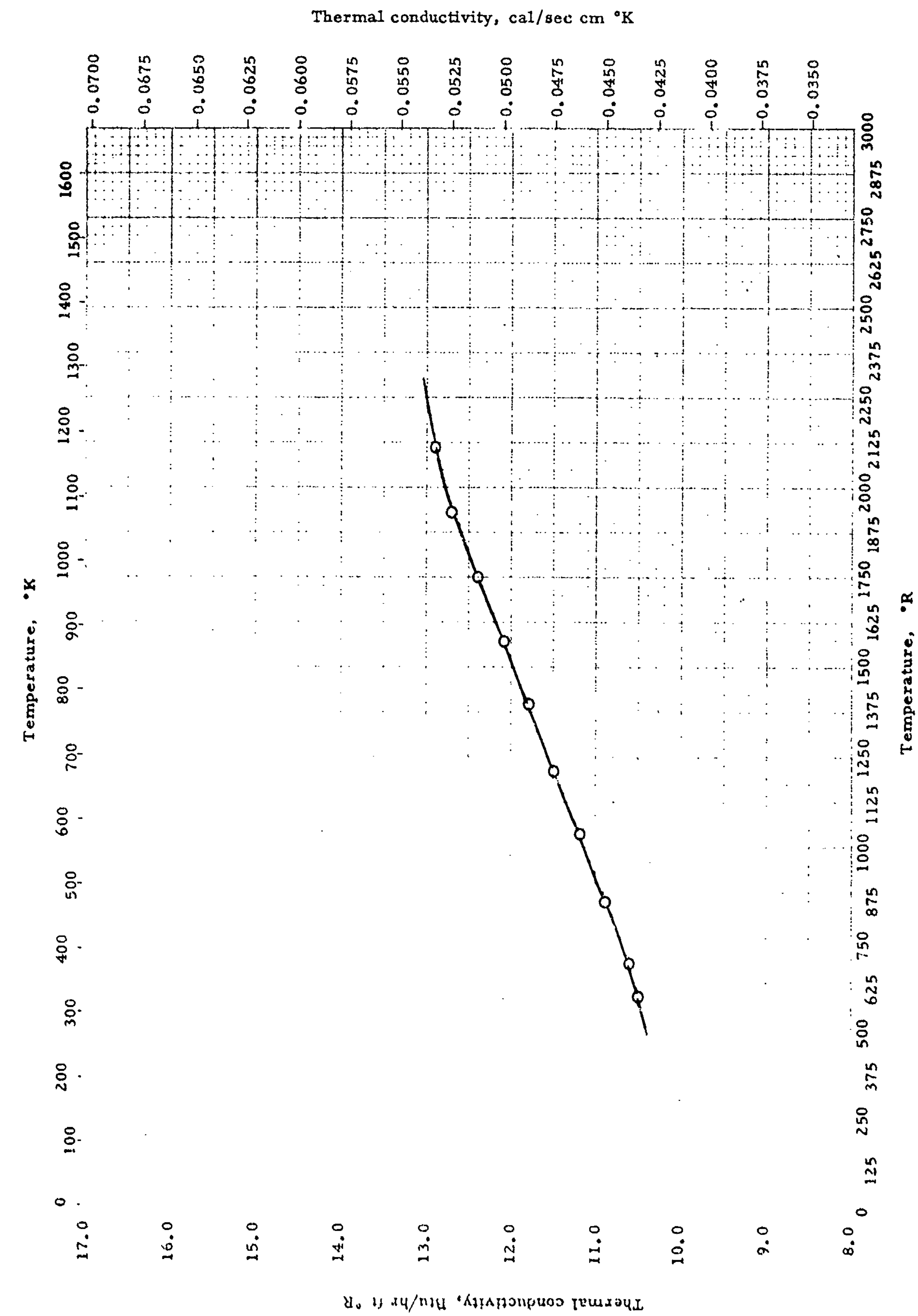


THERMAL CONDUCTIVITY -- NICKEL + IRON + MOLYBDENUM + X

THERMAL CONDUCTIVITY -- NICKEL + IRON + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Silverman, L.	53-2	582-2112	57.1% Ni; 21.4% Fe; 19.0% Mo; 2.5% Mn; 0.072% C	Comparative; rods (Pb primary standard, "Advance" working standard)	

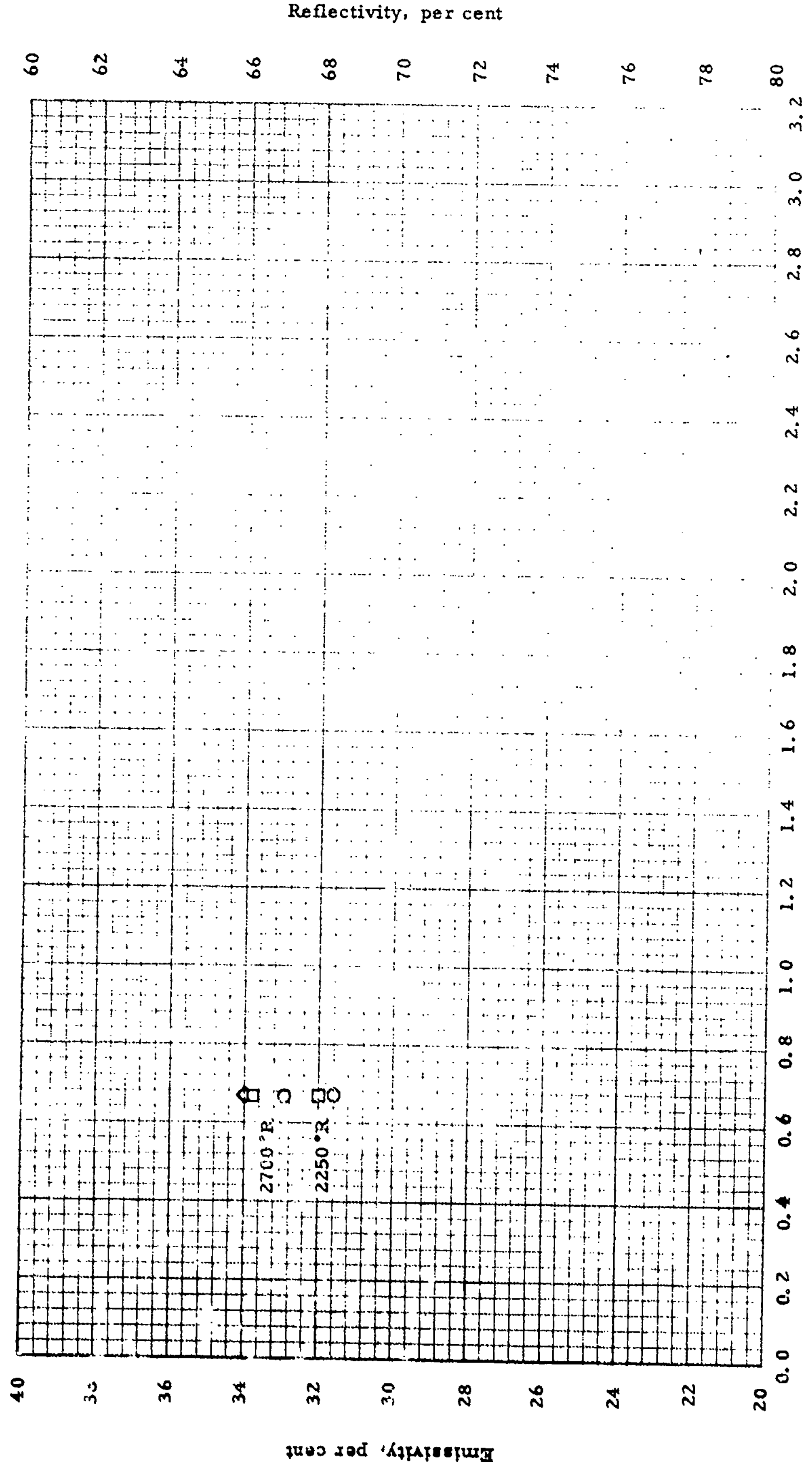


THERMAL CONDUCTIVITY -- NICKEL + IRON + X

THERMAL CONDUCTIVITY -- NICKEL + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Silverman, L.	53-2	582-2112	50.85% Ni; 48.5% Fe; 0.12% Mn; 0.024% C; 0.003% S	Comparative; rods	

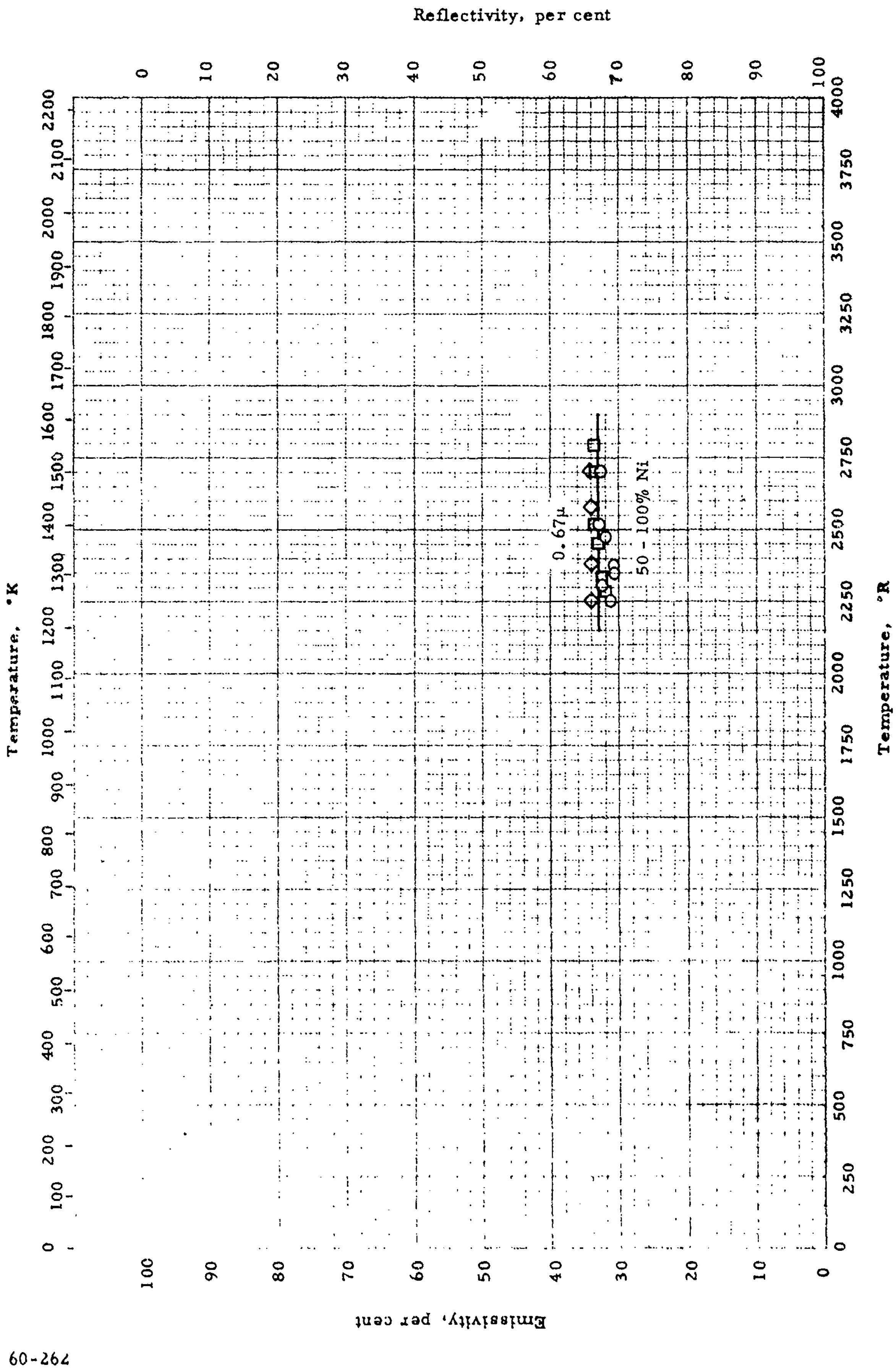


SPECTRAL EMISSIVITY -- NICKEL + IRON

SPECTRAL EMISSIVITY -- NICKEL + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wahlin, H. B., Zenter, R. and Martin, J.	52-112	2250-2700	50% Ni	Spectral normal emissivity at 0.67μ: comparative: surface brightness compared with that of a black body hole	Prepared from reagent quality powders, cold pressed at 70,000 psi, sintered 48 hr. at 1100 °C in H_2 atm., rolled and annealed
□	Ibid.	52-112	2290-2790	75% Ni	Same as above	Same as above
◇	Ibid.	52-112	2250-2700	100% Ni	Same as above	Same as above

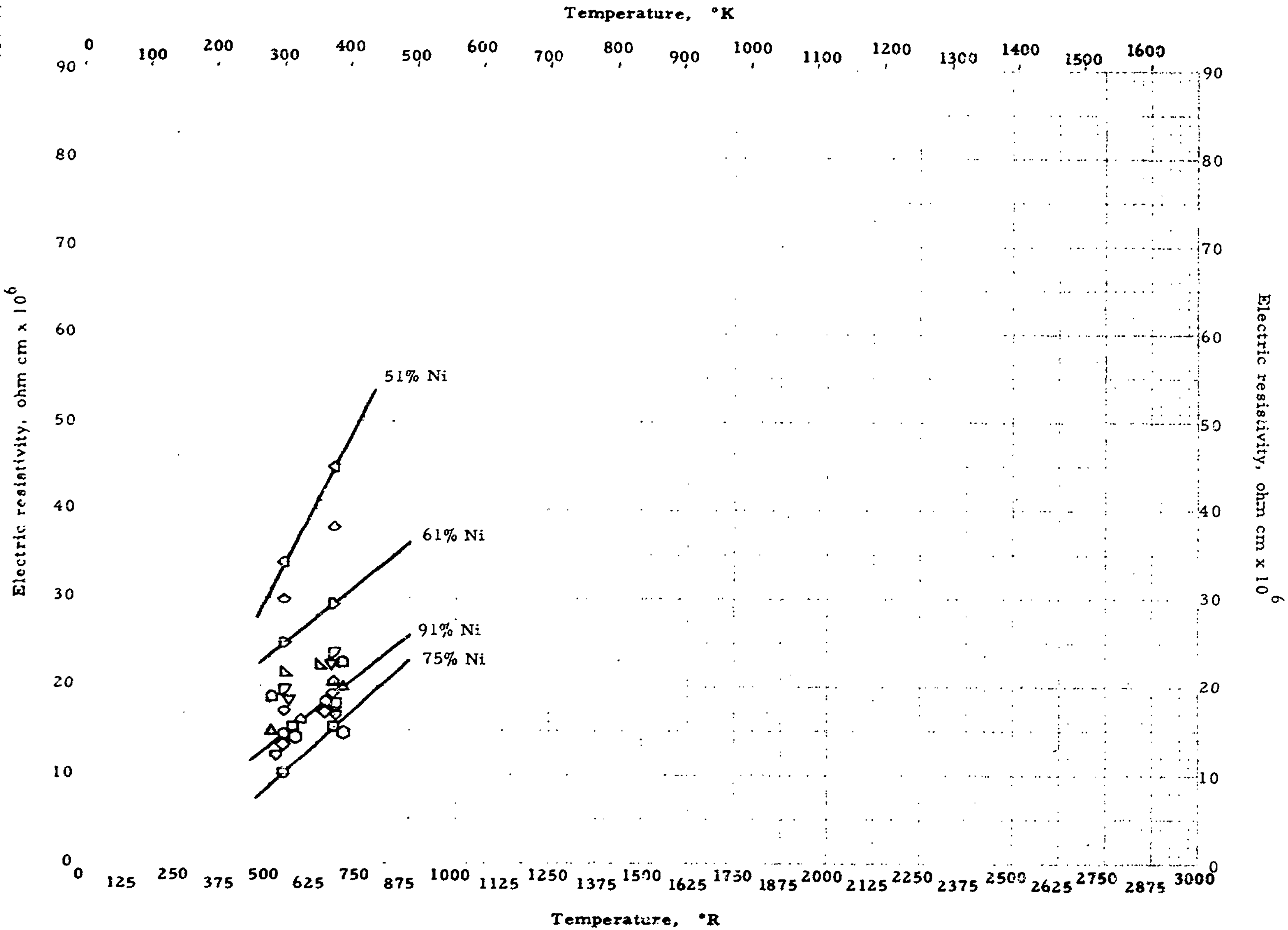


EMISSIVITY -- NICKEL + IRON

EMISSIVITY -- NICKEL + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wahlin, H. B., Zenter, R. and Martin, J.	52-112	2250-2700	50% Ni	Spectral normal emissivity at 0.67μ: comparative: surface brightness compared with that of a black body hole	Prepared from reagent quality powders, cold pressed at 70,000 psi, sintered 48 hr. at 1100 °C in H_2 atm, rolled and annealed
□	Ibid.	52-112	2290-2790	75% Ni	Same as above	Same as above
◇	Ibid.	52-112	2250-2700	100% Ni	Same as above	Same as above



ELECTRIC RESISTIVITY -- NICKEL + IRON

ELECTRIC RESISTIVITY -- NICKEL + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Viting, L. M.	57-69	537-672	91.39% Ni	Potential drop	Made from electrolytic Fe and electrolytic Ni with less than 0.01% C. Slowly cooled 1200 hr. from 450 °F to 400 °C. Auth. also reports data for samples quenched from 800 °C
□	Ibid.	57-69	537-672	84.92% Ni	Same as above	Same as above
△	Ibid.	57-69	537-672	81.32% Ni	Same as above	Same as above
◇	Ibid.	57-69	537-672	80.34% Ni	Same as above	Same as above
▽	Ibid.	57-69	537-672	80.22% Ni	Same as above	Same as above
○	Ibid.	57-69	537-672	79.13% Ni	Same as above	Same as above
⌂	Ibid.	57-69	537-672	77.27% Ni	Same as above	Same as above
▽	Ibid.	57-69	537-672	76.11% Ni	Same as above	Same as above
□	Ibid.	57-69	537-672	75.90% Ni	Same as above	Same as above
△	Ibid.	57-69	537-672	74.18% Ni	Same as above	Same as above
◺	Ibid.	57-69	537-672	73.05% Ni	Same as above	Same as above
◇	Ibid.	57-69	537-672	71.21% Ni	Same as above	Same as above
▷	Ibid.	57-69	537-672	66.43% Ni	Same as above	Same as above
▷	Ibid.	57-69	537-672	61.18% Ni	Same as above	Same as above
◇	Ibid.	57-69	537-672	56.23% Ni	Same as above	Same as above
◁	Ibid.	57-69	537-672	51.24% Ni	Same as above	Same as above

PROPERTIES OF NICKEL + CHROMIUM + IRON + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density, Inconel X . . .	515 lb_m/ft^3	8.25 g/cm^3
Melting Point, Inconel X .	3030 °R	1680 °K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	○	529	8.47
	□	515.3	8.254
	▽	515	8.25
	⬡	529	8.47
	△	524	8.40
	◡	512	8.20
	▽	509	8.15

Melting Point:		°R	°K
	△	3030 ± 30	1683 ± 15
	◇	2810	1555

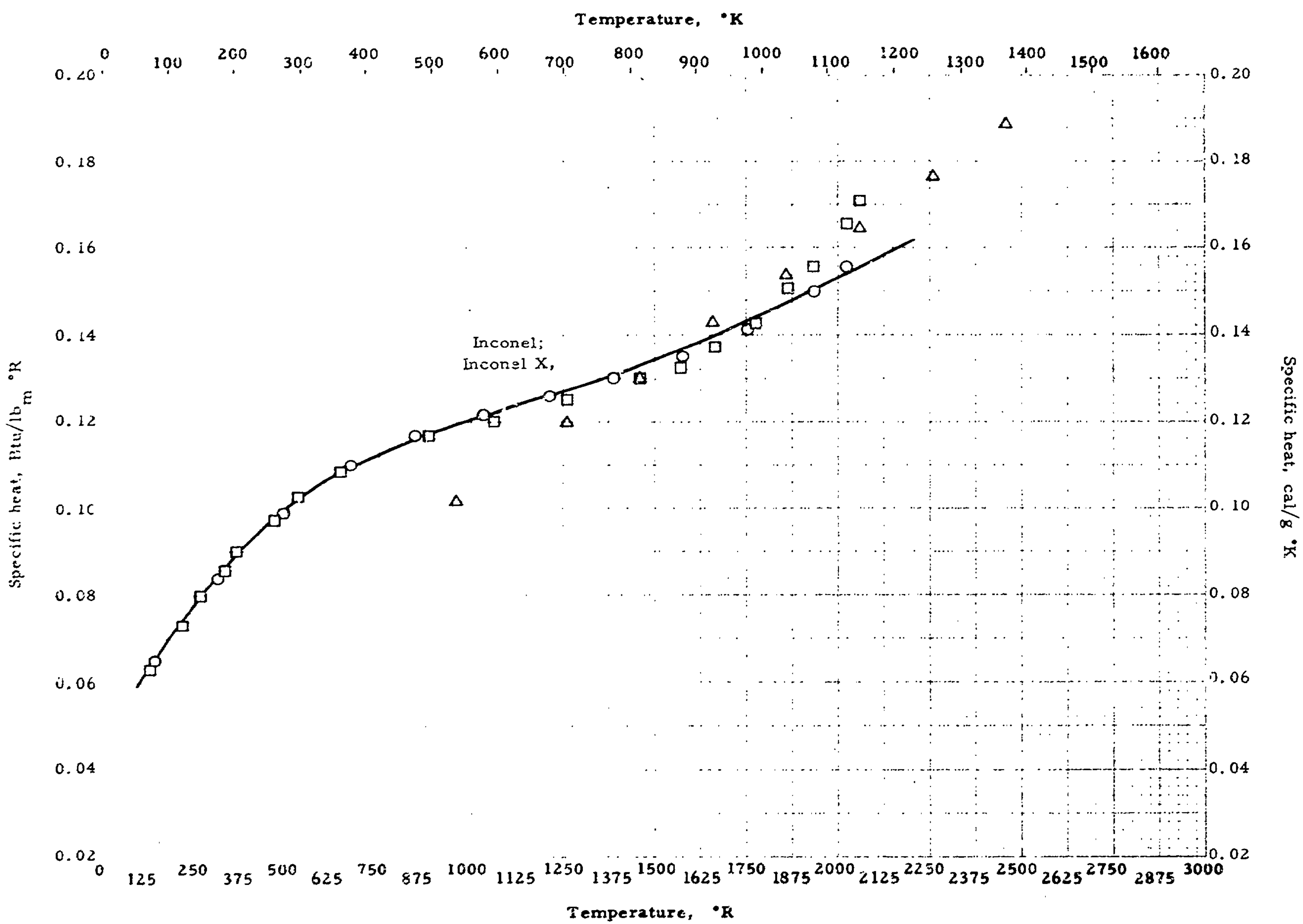
Heat of Fusion:	Btu/lb_m	cal/g

Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5	528	Inconel; Nominal: 72% Ni min.; 14-17% Cr; 6-10% Fe	ρ: weight and volume by water displacement	Annealed
□	Ibid.	58-5	528	Inconel "X"; nominal: 70% Ni min; 14-16% Cr; 5-9% Fe; 2.25-2.75% Ti; 0.7-1.2% Nb; 0.4-1.0% Al; 0.3-1.0% Mn	ρ: same as above	
△	Int. Nickel Co.	49-13	2910-3060	Inconel "X"; nominal composition as above	MP: not given	
▽	Lucks, C.F., Thompson, H.B. et al.	51-65	528	Inconel "X". 72.94% Ni; 14.65% Cr; 6.97% Fe; 2.44% Ti; 1.01% Nb; 0.93% Al; 0.54% Mn; 0.46% Si; 0.03% C; 0.02% Cu	ρ: weight in air and in water	Hot rolled. Solution heat treated 3 hr. at 2100°F, air cooled, double aged; 24 hr. 1550°F, air cooled, 20 hr. at 1300°F, and cooled
○	Ibid.	51-65	528	Inconel. 78.92% Ni; 14.62% Cr; 5.80% Fe; 0.23% Mn; 0.19% Si; 0.09% C; 0.007% S	ρ: same as above	Hot rolled. Annealed 3 hr. at 1600°F, 15 min. at 1800°F and air cooled
◇	Willmore, T.A. and Bennett, D.G.	55-118	2810	"Inconel X Type" 73.19% Ni; 14.77% Cr; 8.60% Fe; 1.84% Ti; 0.95% ea. Cr, Ta; 0.47% Mo; 0.18% Al; traces of Cu, Ca, B, Zn	MP: visual observation during manufacture	Sample of Inconel X used did not meet compositional requirements
⌂	Seibel, R.D. and Mason, G.L.	57-156	Room	Inconel: 15.15% Cr; 8.24% Fe; 0.35% Ti; 0.30% Mn; 0.23% Si; 0.094% Co; 0.077% C	ρ: not given	
⊍	Ibid.	57-156	Room	Inconel X: 14.04% Cr; 7.93% Fe; 2.73% Ti; 0.67% Mn; 0.57% Nb; 0.56% Al; 0.41% Si; 0.064% C	ρ: same as above	
⊽	Ibid.	57-156	Room	Hastelloy X: 19.79% Cr; 17.95% Fe; 7.43% Mo; 1.58% Co; 0.86% Si; 0.81% Mn; 0.19% Ti; 0.13% W; 0.11% C	ρ: same as above	

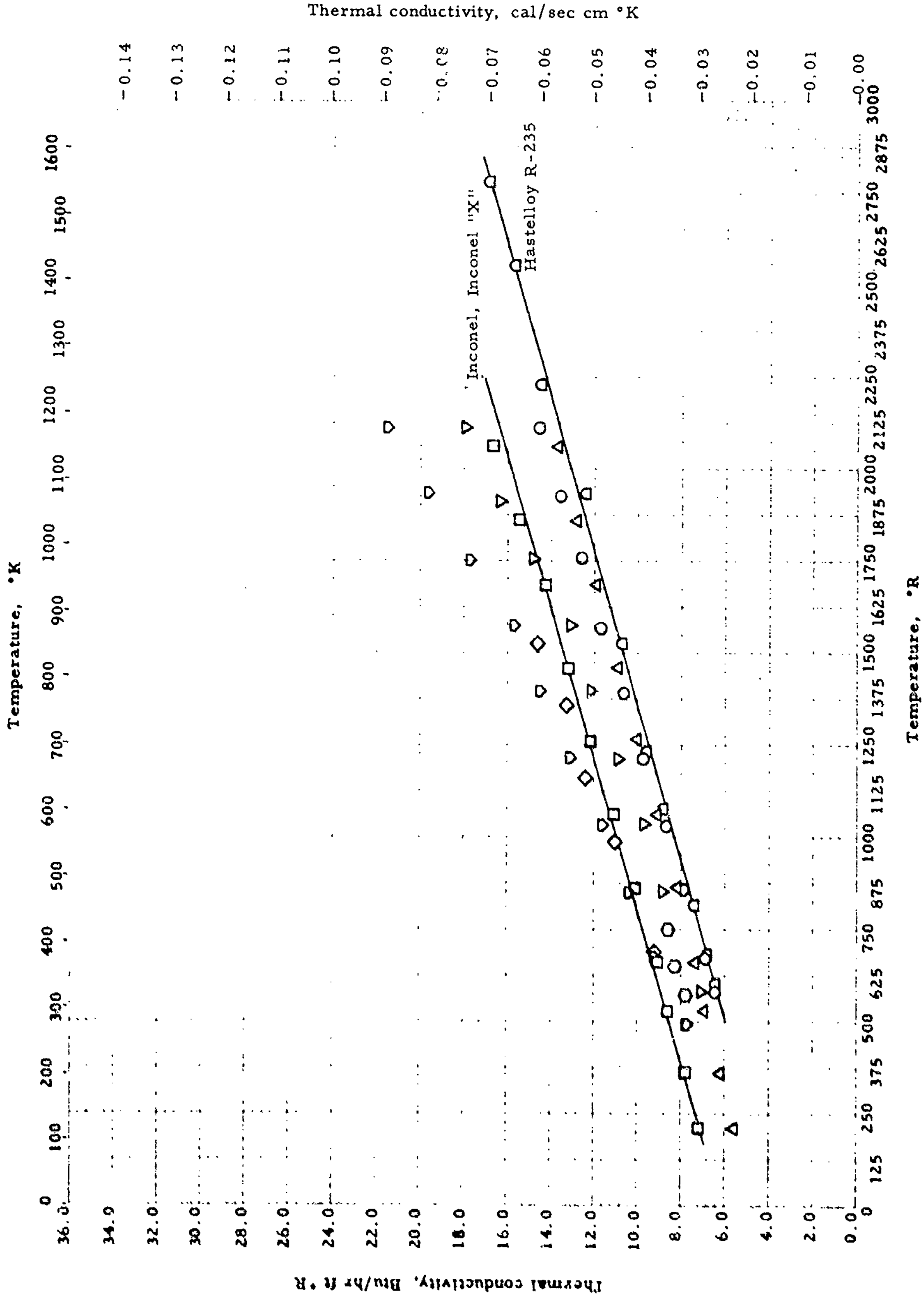


SPECIFIC HEAT -- NICKEL + CHROMIUM + IRON + X

SPECIFIC HEAT -- NICKEL + CHROMIUM + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F., Matolich, J., Van Valzor, J. A. et al.	5[illegible]-33 also 54-27 58-5	14[illegible]-2022	Inconel; nominal: 77% Ni; 15% Cr; 7% Fe; X	Drop method; ice calorimeter	Hot rolled; annealed 3 hr. at 1600°F; 15 min. at 1800°F, air cooled
□	Ibid.	57-[illegible]3 also 54-27 58-5	2[illegible]0-2060	Inconel "X"; nominal: 73% Ni; 15% Cr; 7% Fe; 2.5% Ti; X	Same as above	Hot rolled; solution treated 3 hr. at 2100°F, air cooled. Aged 24 hr. at 1550°F, 20 hr. at 1300°F, air cooled
△	Fieldhouse, I. B., Hedge, J. C. and Lang, J. I.	58-2	960-2760	Hastelloy R-235. Nominal: ~66% Ni; 14-17% Cr; 9 - 11% Fe; 4.5 - 6.5% Mo; 2.25-2.75% Ti; <2.50% Co; 1.75 - 2.25% Al; <1% ea. Mn, Si; <0.16% C	Drop method; liquid calorimeter	Tested in He atmos.

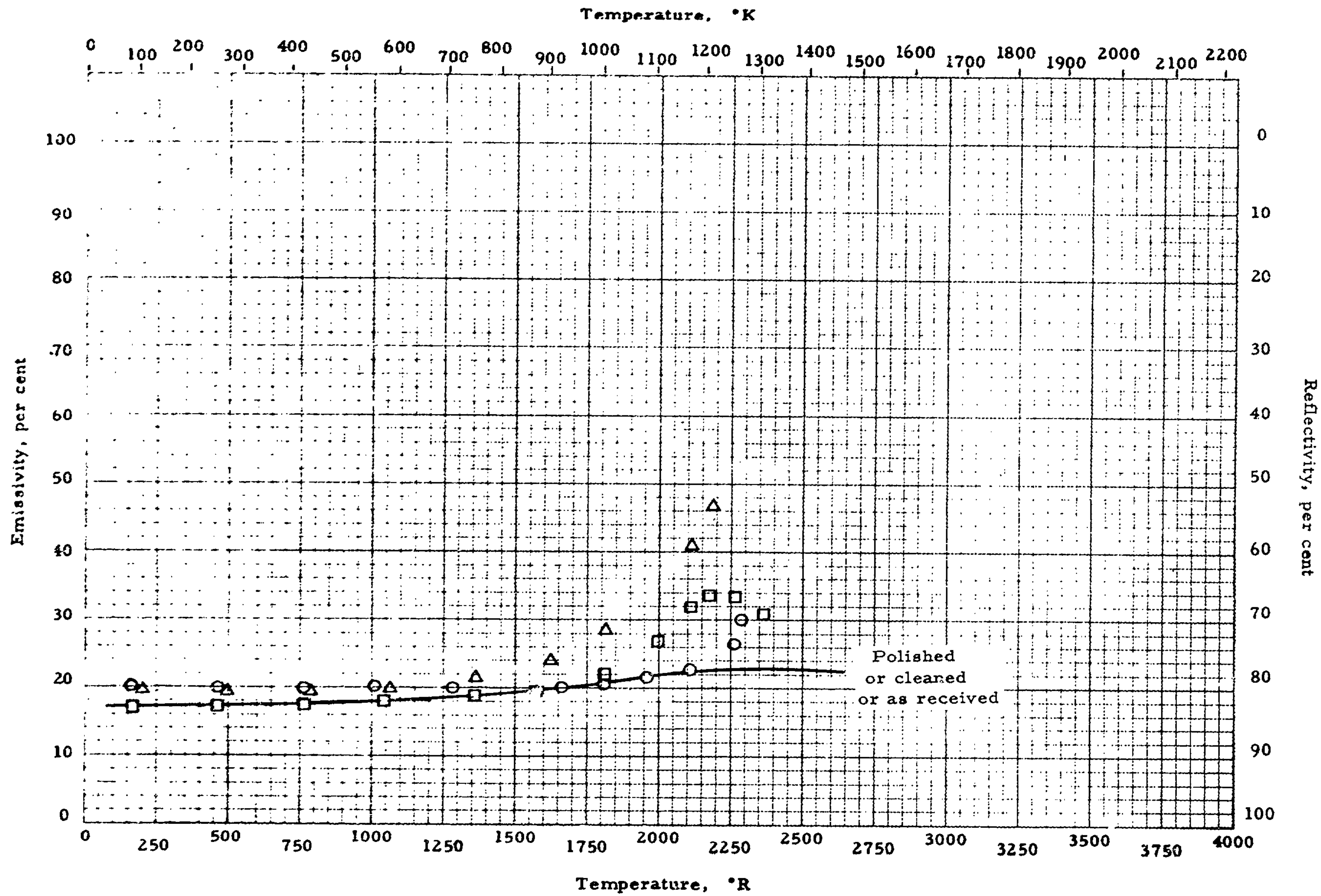


THERMAL CONDUCTIVITY -- NICKEL + CHROMIUM + IRON + X

THERMAL CONDUCTIVITY -- NICKEL + CHROMIUM + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Silverman, L.	53-2	582-2112	Inconel. 78.13% Ni; 13.94% Cr; 6.33% Fe; 0.33% Si; 0.32% Mn; 0.30% Co	Comparative; rods. Pb primary standard; "Advance" working standard	
□	Lucks, C.F. and Deem, H.W.	58-5 also 51-65	210-2060	Inconel. Nominal: 72% min. Ni; 14-17% Cr; 6-10% Fe. ρ = 529 lb_m/ft^3	Comparative; rods (Armco Iron Standard)	Hot rolled; annealed 3 hr. at 1600°F, 15 min. at 1800°F, and air cooled
△	Ibid.	58-5 also 51-65	210-2060	Inconel "X". Nominal: 70% min. Ni; 14-16% Cr; 5-9% Fe; 2.25-2.75% Ti; 0.7-1.2% Nb; 0.4-1.0% Al; 0.3-1.0% Mn. ρ = 515 lb_m/ft^3	Same as above	Hot rolled; solution treated 3 hr. at 2100°F, air cooled, aged 24 hr. at 1550°F, 20 hr. at 1300°F, air cooled
◇	Evans Jr., Jerry E.	51-16	680-1525	Inconel "X". 73.4% Ni; 14.6% Cr; 6.9% Fe; 2.3% Ti; 1.0% Nb; 0.7% Al; 0.05% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%
▽	International Nickel Co.	49-13	582-2112	Inconel "X"	Not given	Based on tests conducted at Lehigh U.
○	Koenig, John H.	53-43	570-750	Inconel	Comparative; rods (Cu standard)	In vacuum
○	Fieldhouse, I.B., Hedge, J.C. and Lang, J.I.	58-2	605-2780	Hastelloy R-235. Nominal: 66% Ni (approx.); 14-17% Cr; 9-11% Fe; 4.5-6.5% Mo; 2.25-2.75% Ti; 1.75-2.25% Al; < 2.5% Co	Radial heat flow in cylinder of stacked disks	In He atmos.
○	Hogan, C.L. and Sawyer, R.B.	52-75	492-2112	Inconel "X". 73.19% Ni; 14.38% Cr; 6.99% Fe; 0.83% Al; 0.47% Mn; 0.39% Si; 0.03% ea. Cu, C; 0.007% S	Temp. distribution in rod heated at one end; meas. heat loss from surface	

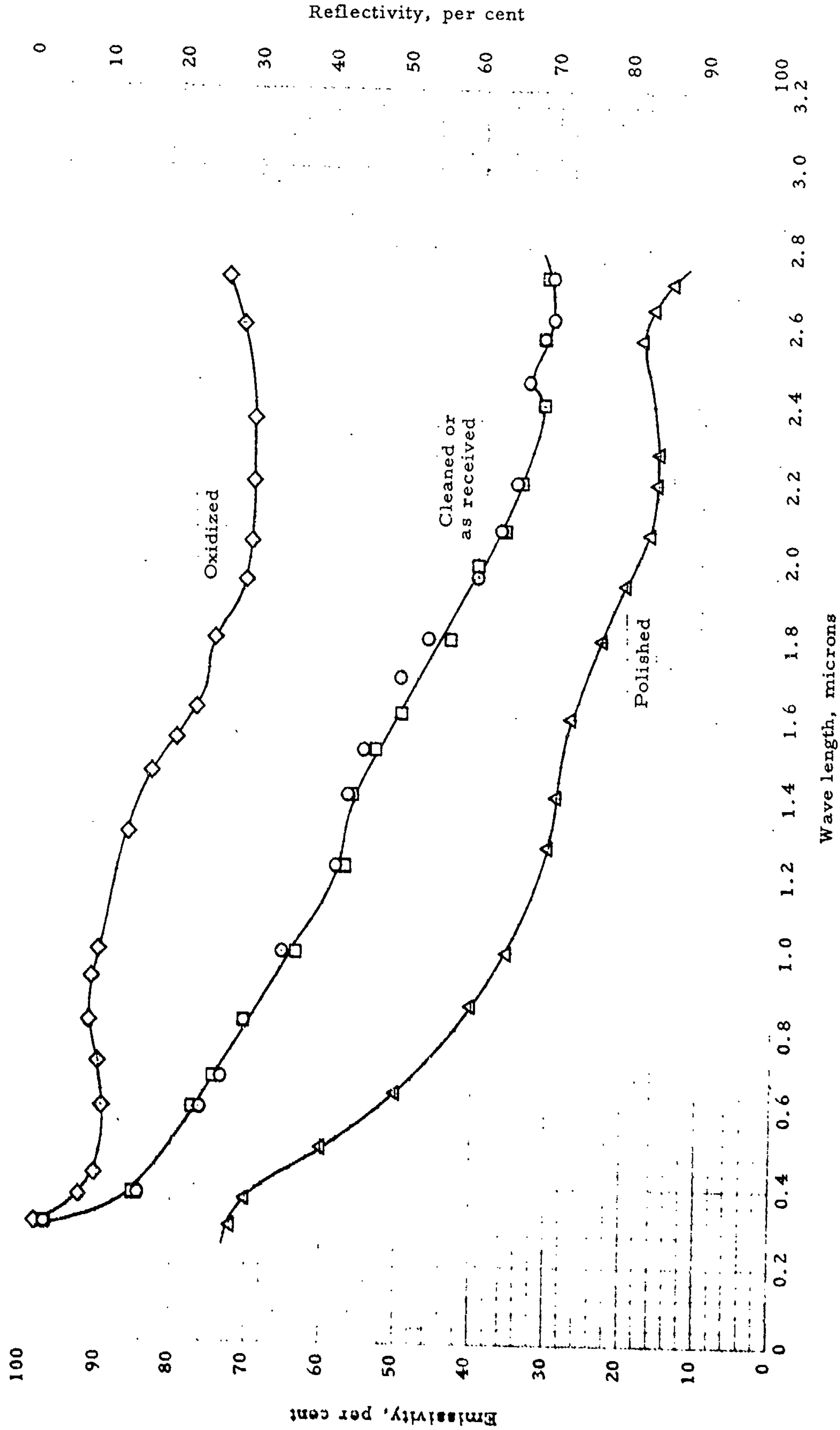


EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel B)

EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel B)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G. B.	54-122	160-2290	Inconel B. Nominal: 72% Ni min; 16 - 18% Cr; 9.5% Fe max; 1% Mn max; 0.15% C as received	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermopile in 10μ Hg. Temp. by Cu-Const. Chromel-Alumel thermocouple	Wiped with toluene until clean, then with methyl alcohol
□	Ibid.	54-122	160-2360	Same as above; clean and smooth	Same as above	Scrubbed with Bon Ami; washed with water, dried, wiped with toluene and alcohol
△	Ibid.	54-122	160-2185	Same as above; polished	Same as above	Buffed until mirror-like and free of scratches. Washed with soap and dried



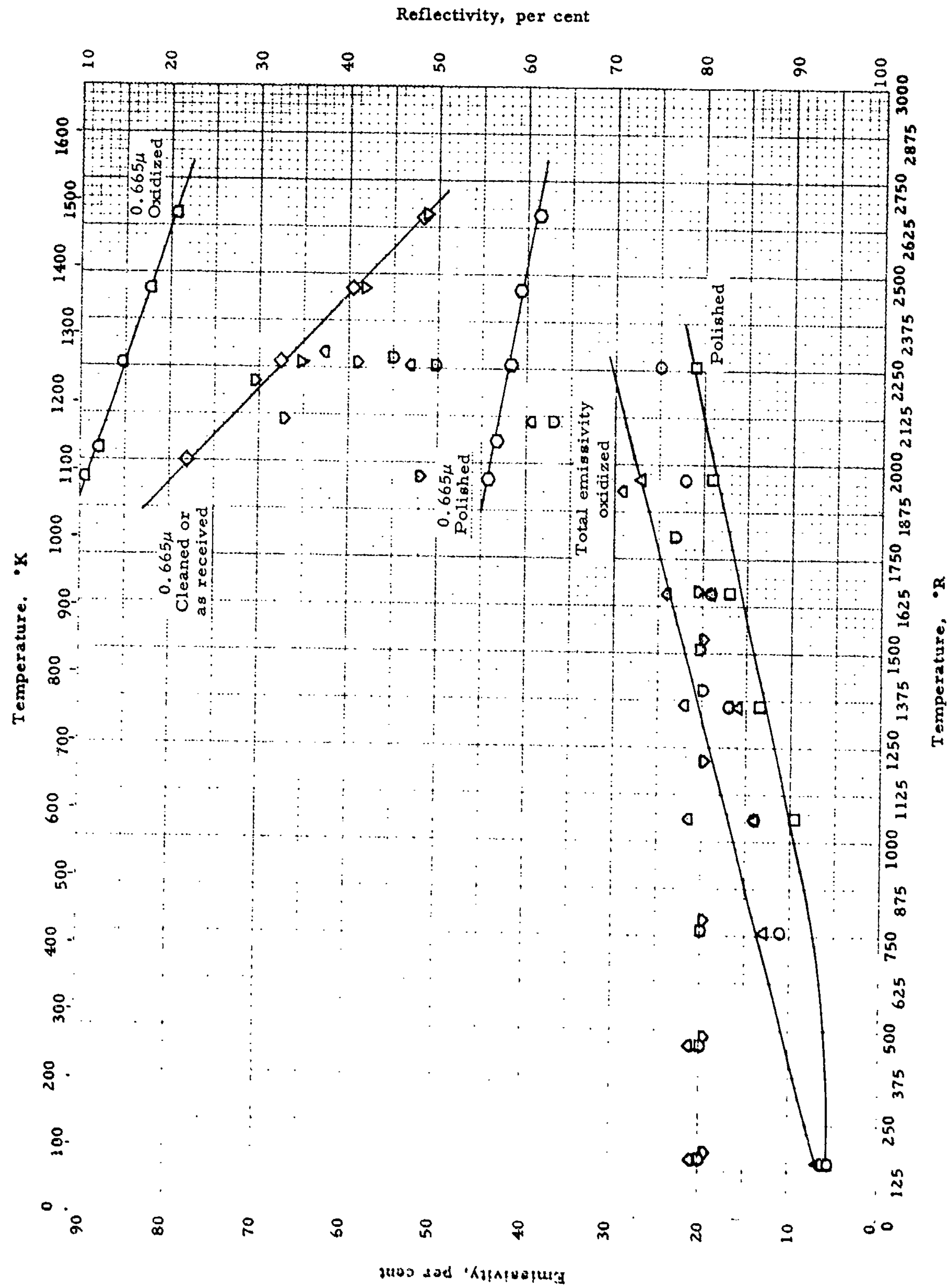
SPECTRAL EMISSIVITY -- NICKEL + CHROMIUM + IRON + X

Inconel X

SPECTRAL EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
Inconel X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Olson, O.H. and Morris, J.C.	58-1	Room	Inconel X. Nominal: 73% Ni (inc. Co); 15% Cr; 7% Fe; 2.5% Ti; 1.0% Nb (inc. Ta); 0.90% Al; 0.5% Mn; 0.40% Si; 0.05% Cu; 0.04% C; 0.01% S	Spectral reflectivity at 9°; sample compared with $MgCO_3$ standard in MgO integrating sphere; quartz lens, PbS detector	Surface as received
□	Ibid.	58-1	Room	Same as above	Same as above	Detergent cleaned
△	Ibid.	58-1	Room	Same as above	Same as above	Surface polished
◇	Ibid.	58-1	Room	Same as above	Same as above	Surface oxidized 30 min. at red heat in air

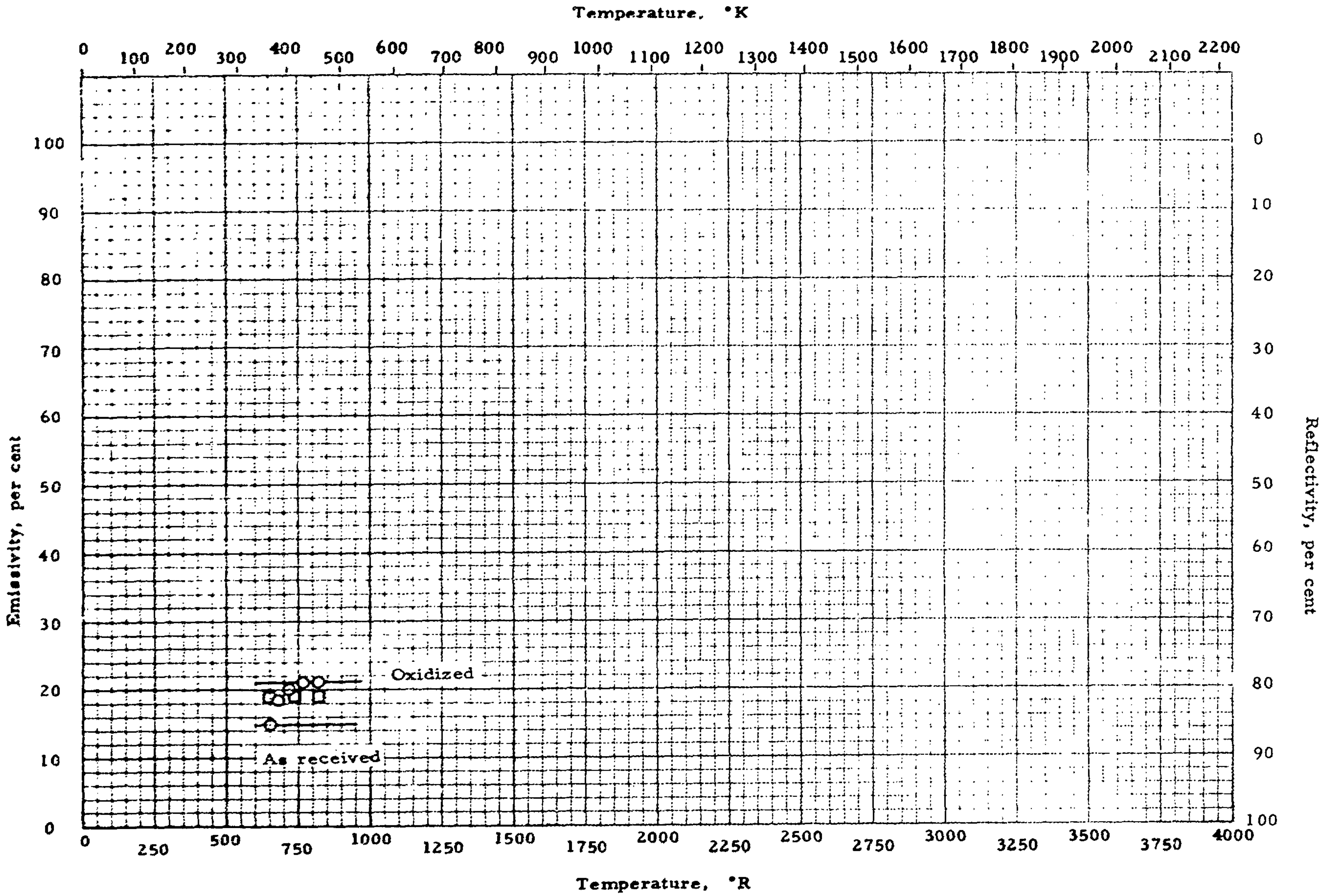


EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel X)

EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel X)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H. et al.	57-8	150-2260	Inconel X; nominal: 73% Ni; 15% Cr; 7% Fe; 2.5% Ti; 1.0% Nb; 0.90% Al; 0.50% Mn; 0.40% Si; 0.05% Cu; 0.04% C; 0.01% S	Total normal emissivity: comparative; radiant heat flow compared with that of a black body, thermistor bolometer	Surfaces as received and cleaned
□	Ibid.	57-8	150-2260	Same as above	Same as above	Surface polished
△	Ibid.	57-8	150-2260	Same as above	Same as above	Surface oxidized 30 min. at red heat in air
◇	Ibid.	57-8	2000-2650	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Surface as received
▽	Ibid	57-8	1960-2660	Same as above	Same as above	Surface cleaned by detergent
○	Ibid.	57-8	.960-2660	Same as above	Same as above	Surface polished
□	Ibid.	57-8	1960-2660	Same as above	Same as above	Surface oxidized 30 min. at red heat in air
△	Wilkes, G. B.	54-122	160-2080	Inconel X; nominal: 73% Ni; 15% Cr; 7% Fe; 2.5% Ti; 1.0% Nb; 0.7% Al; 0.5% Mn; 0.4% Si; 0.04% C	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, in He atm. of 10μ Hg, temp. by thermocouple	Also gives data for cooling and reheating cycles. As received: cleaned with toluene and alcohol
◇	Ibid.	54-122	160-2080	Same as above	Same as above	Also gives data for cooling and reheating cycles. Clean and smooth: scrubbed with Bon Ami and cleaned with toluene and alcohol
▽	Ibid.	54-122	160-2080	Same as above	Same as above	Also gives data for cooling and reheating cycles. Polished: buffed until mirror-like

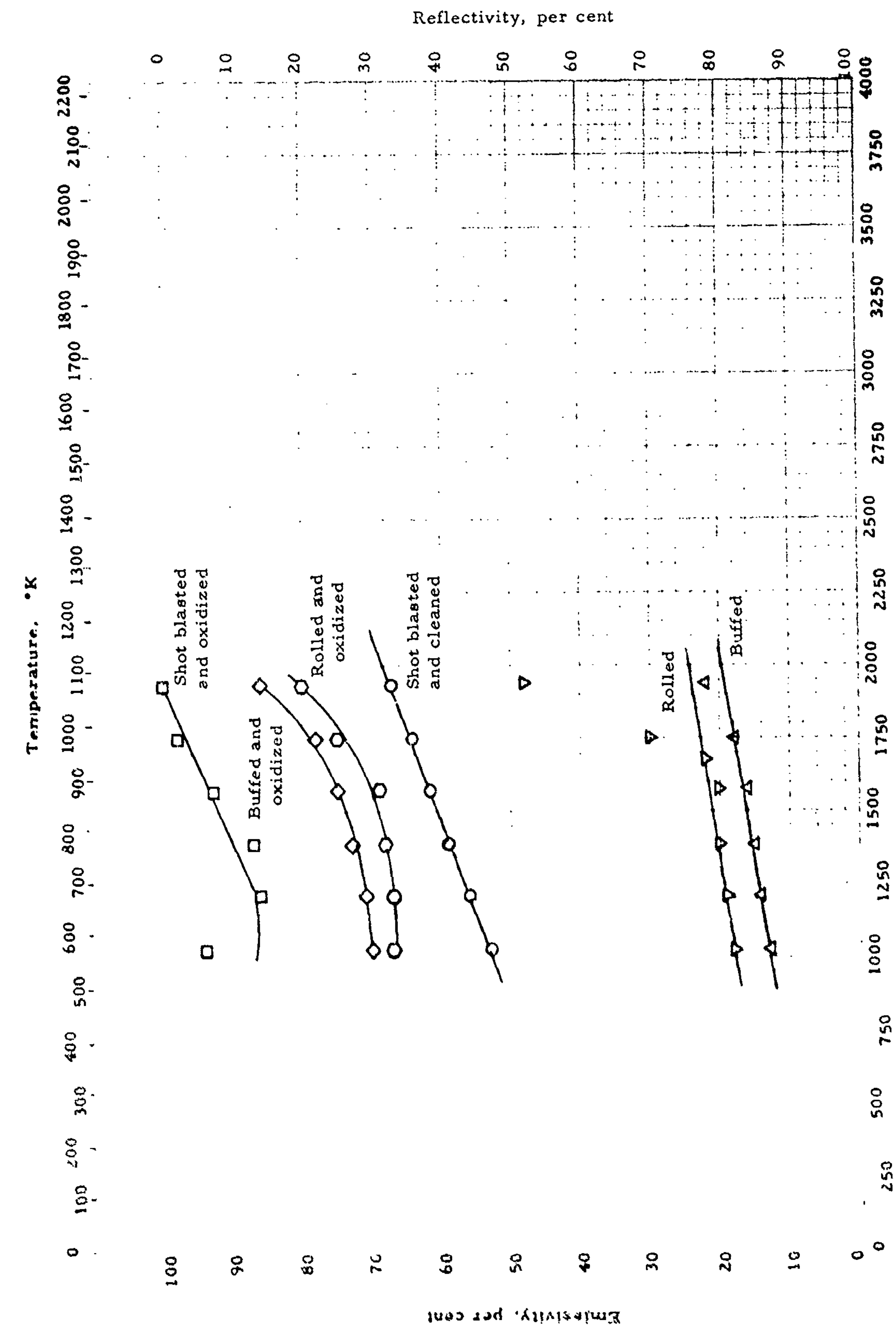


EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel)

EMISSIVITY -- NICKEL + CHROMIUM + IRON + X
(Inconel)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Boetter, L. M. K., Bromberg, R. and Grier, J. T.	44-10	650-820	Inconel. Nominal: 14-17% Cr; 6-10% Fe; 1% Mn max; 0.50% ea. Cu, Si max; 0.15% C max; 0.15% S max	Total emissivity: Radiant heat meas. with thermopile and radiometer	Untreated surface
□	Ibid.	44-10	650-810	Same as above	Same as above	Oxidized at 1400°F to a brassy color

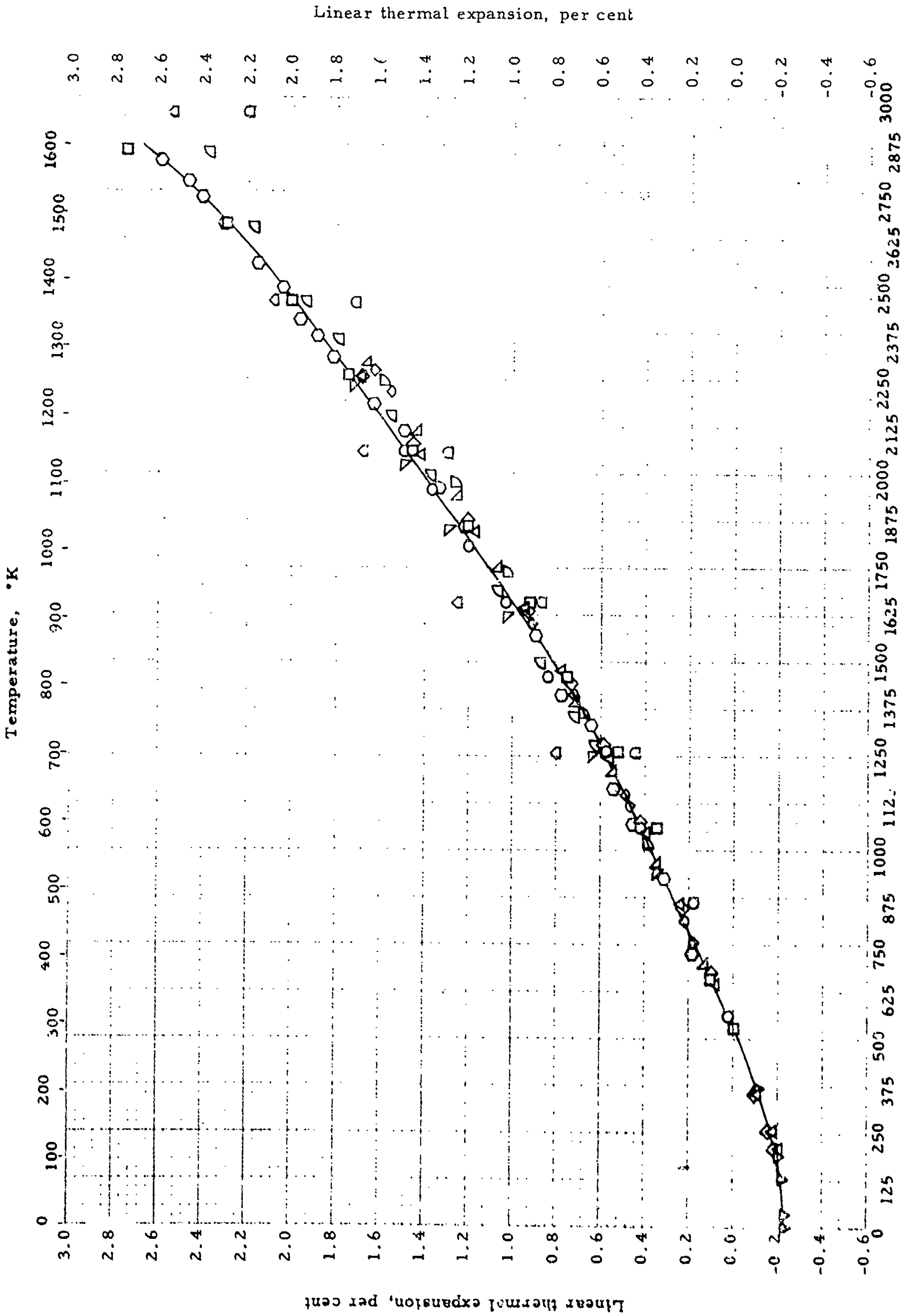


EMISSIVITY -- NICKEL + CHROMIUM + IRON
(Nimonic 75)

EMISSIVITY -- NICKEL + CHROMIUM + IRON
(Nimonic 75)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sully, A. H. Brandes, E. A. and Waterhouse, R. B.	52-81	1032-1932	Nimonic 75, nominal: 77% Ni (inc. Co); 20% Cr; 2% Fe	Total normal emissivity: radiant heat meas. with thermopile; sample temp. by calibrated Pt-Rh thermocouple	Shot blasted, unoxidized
□	Ibid.	52-81	1032-1932	Same as above	Same as above	Shot blasted; oxidized at 1200°C
△	Ibid.	52-81	1032-1932	Same as above	Same as above	Buffed, unoxidized
◇	Ibid.	52-81	1032-1932	Same as above	Same as above	Buffed, oxidized at 1200°C
▽	Ibid.	52-81	1032-1932	Same as above	Same as above	As rolled, unoxidized
○	Ibid.	52-81	1032-1932	Same as above	Same as above	As rolled, oxidized at 1200°C



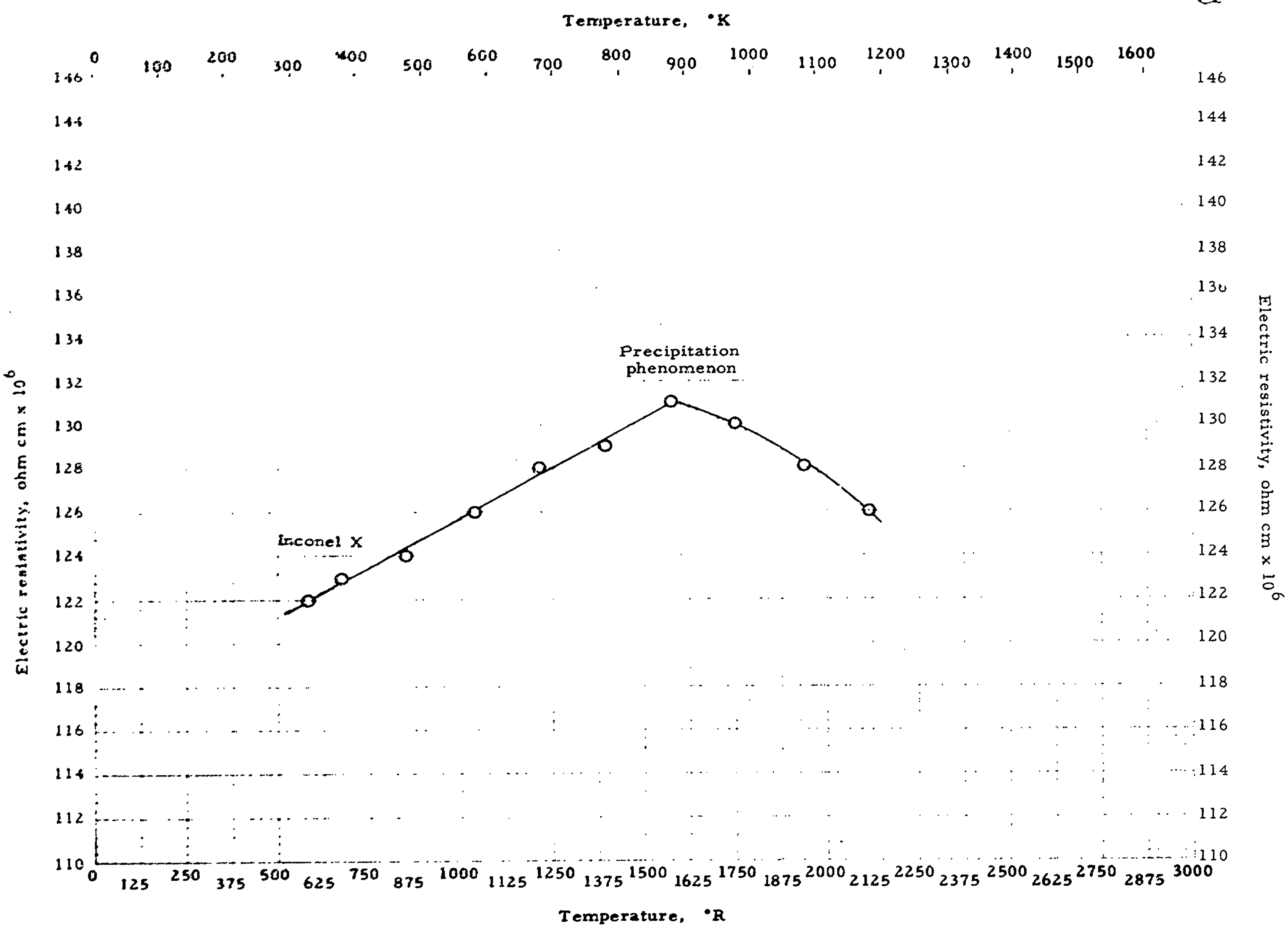
LINEAR THERMAL EXPANSION -- NICKEL + CHROMIUM + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	International Nickel Co. Inc.	49-13	560-2060	Inconel X : Nominal: 70% min. Ni; 14 - 16% Cr; 5 - 9% Fe; 2.25 - 2.75% Ti; 0.7 - 1.2% Nb; 0.4 - 1.0% Al; 0.3 - 1.0% Mn; Max. of 0.50% Si; 0.20% Cu; 0.08% C; 0.01% S	Not given	Measured by Internation Nickel Co.
□	Apblett, W.R. and Pellini, W.S.	51-5	528-2860	Inconel X : 74.5% Ni; 14.5% Cr; 7.0% Fe; 2.5% Ti; 1.0% Nb; 0.48% Mn; 0.48% Si; 0.05% C	Strain gages on channel-shaped clip fastened to pins welded on sample	Heated at 200°F/sec
△	Lucks, C.F. and Deem, H.W.	58-5 also 51-65	210-2260	Inconel X 72.94% Ni; 14.65% Cr; 6.97% Fe; 2.44% Ti; 1.01% Nb; 0.93% Al; 0.54% Mn; 0.46% Si; 0.03% C; 0.02% Cu. ρ = 515 lb_m/ft^3	Quartz tube dilatometer	Hot rolled; solution treated 3 hr. at 2100°F, air cooled, aged 24 hr. at 1550°F, then 20 hr. at 1300°F; air cooled. Tested in vacuum
◇	Ibid.	58-5 also 51-65	210-2260	Inconel: 78.92% Ni; 14.62% Cr; 5.80% Fe; 0.23% Mn; 0.19% Si; 0.09% C; 0.007% S. ρ = 529 lb_m/ft^3	Same as above	Hot rolled; annealed 3 hr. at 1600°F; 15 min. at 1800°F; air cooled
▽	Laquer, H.L.	52-39	0-540	Inconel. Nominal: 72% min. Ni; 14 - 17% Cr; 6 - 10% Fe; max. of 1.0% Mn; 0.5% ea. Cu, Si; 0.15% C; 0.015% S	Interferometer	Data given are integrated values of expansion coeff. measured by Altman, Rubin, and Johnston from 1949-1951 (unpubl.)
O	Fieldhouse, I.B., Hedge, J.C. and Lang, J.I.	58-2	540-2828	Hastelloy R-235: Nominal: 66% Ni; 14 - 17% Cr; 9 - 11% Fe; 4.5 - 6.5% Mo; 2.25 - 2.75% Ti; <2.5% Co; 1.75 - 2.25% Al; <1% ea. Mn, Si; <0.16% C	Telemicroscopes sighting on sample	Tested in He atmos.
◘	Seibel, R.D. and Mason, G.L.	57-156	1260-2960	Inconel X: 73.03% Ni by diff.; 14.04% Cr; 7.93% Fe; 2.73% Ti; 0.67% Mn; 0.57% Nb; 0.56% Al; 0.41% Si; 0.064% C. ρ = 512 lb_m/ft^3	Alumina tube differential dilatometer	Calibrated against Cu and Mo. Tested in vac. at 3 - 5°F/min. rise
◬	Ibid.	57-156	1260-2960	Inconel: 75.54% Ni by diff.; 15.15% Cr; 8.24% Fe; 0.35% Ti; 0.30% Mn; 0.23% Si; 0.094% Co; 0.077% C. ρ = 524 lb_m/ft^3	Same as above	Same as above
◿	Ibid.	57-156	1260-2860	Hastelloy X: 51.15% Ni by diff.; 19.79% Cr; 17.95% Fe; 7.43% Mo; 1.58% Co; 0.86% Si; 0.81% Mn; 0.19% Ti; 0.13% W; 0.11% C. ρ = 509 lb_m/ft^3	Same as above	Same as above

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
△	Hidnert, P.	57-134	528-2292	Inconel, three samples a) 75.99% Ni; 14.42% Cr; 8.87% Fe; 0.28% Mn; 0.22% Cu; 0.17% Si; 0.02% C; 0.007% S b) 75.64% Ni; 15.32% Cr; 8.17% Fe; 0.33% Mn; 0.21% Si; 0.19% Cu; 0.11% C; 0.007% S c) 76.65% Ni; 14.96% Cr; 7.89% Fe; 2.6% Mn; 0.19% Si; 0.15% Cu; 0.07% C; 0.007% S	Not described here, refers to others	Hot rolled and machined, annealed by rapid insertion into preheated furnace at 2050°F for 9-1/4 min, cooled in quiescent air. Heating data. Average of three samples plotted, max. deviation of ± 0.6%
○	Ibid.	57-134	528-2292	Sample (a) above	Same as above	Same heat treatment as above. Cooling data
□	Ibid.	57-134	528-2292	Sample (b) above	Same as above	Same as above
⬡	Ibid.	57-134	528-2292	Sample (c) above	Same as above	Same as above
▽	Sailer, H.A., et al.	53-127	960-2260	75% GE-62 Braze; 25% AISI 310 Nominal: 56.88% Ni; 21.25% Cr; 12.80% Fe; 8.62% Si; <0.06% C; <0.50% Mn	Recording dilatometer, tested in vac. at 5-1/2°F/min. rise	Arc melted, cast, heat treated 24 hr. at 1800°F in vac. Plotted data are avg. of 2 complete heating and cooling cycles



ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM + IRON + X
Inconel

ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM + IRON + X
Inconel

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	International Nickel Company Inc.	49-13	582-2112	Inconel X : >70% Ni; 14 - 16% Cr; 5 - 9% Fe; 2.25 - 2.75% Ti; 0.7 - 1.2% Nb; 0.4 - 1.0% Al; 0.3 - 1.0% Mn; Max. of 0.50% Si, 0.20% Cu, 0.08% C, 0.01% S	Not given	Data furnished Int. Nickel Co. by Bell Aircraft, based on tests at Lehigh Univ.
O	Hogan, C. L. and Sawyer, R. B.	52-75	582-2112	Inconel X	Potential drop; sample temp. by Chromel-Alumel thermocouple	Auth. report apparently the same values as above article

Symbol	Composition, wt %			Melting Point	
	Ni	Cr	Mo	°R	°K
O	40	30	30	2796	1553
	40	48	12	2805	1568
	50	40	10	2940	1633
	55	22.5	22.5	2814	1563
	55	36	9	2859	1588
	65	28	7	3012	1673

MELTING POINT -- NICKEL + CHROMIUM + MOLYBDENUM

MELTING POINT -- NICKEL + CHROMIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
C	Binder, I. and Moskowitz, D.	55-76	2796-3012	Alloy series 40-65% Ni; 22.5-48% Cr; 7-30% Mo. For individual alloy composition see Reported Values	MP: visual observation of powder in graphite crucible; optical pyrometer estimated accurate to ± 25°C	Also see Ni + Mo + Cr alloys

PROPERTIES OF NICKEL + CHROMIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	510 lb_m/ft^3 *	8.1 g/cm^3 *
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Value for "Evanohm"; for others see Reported Values below.

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	○	510	8.1
	□	521	8.35
	△	556.9	8.921

Melting Point:	°R	°K

Heat of Fusion:	Btu/lb_m	cal/g

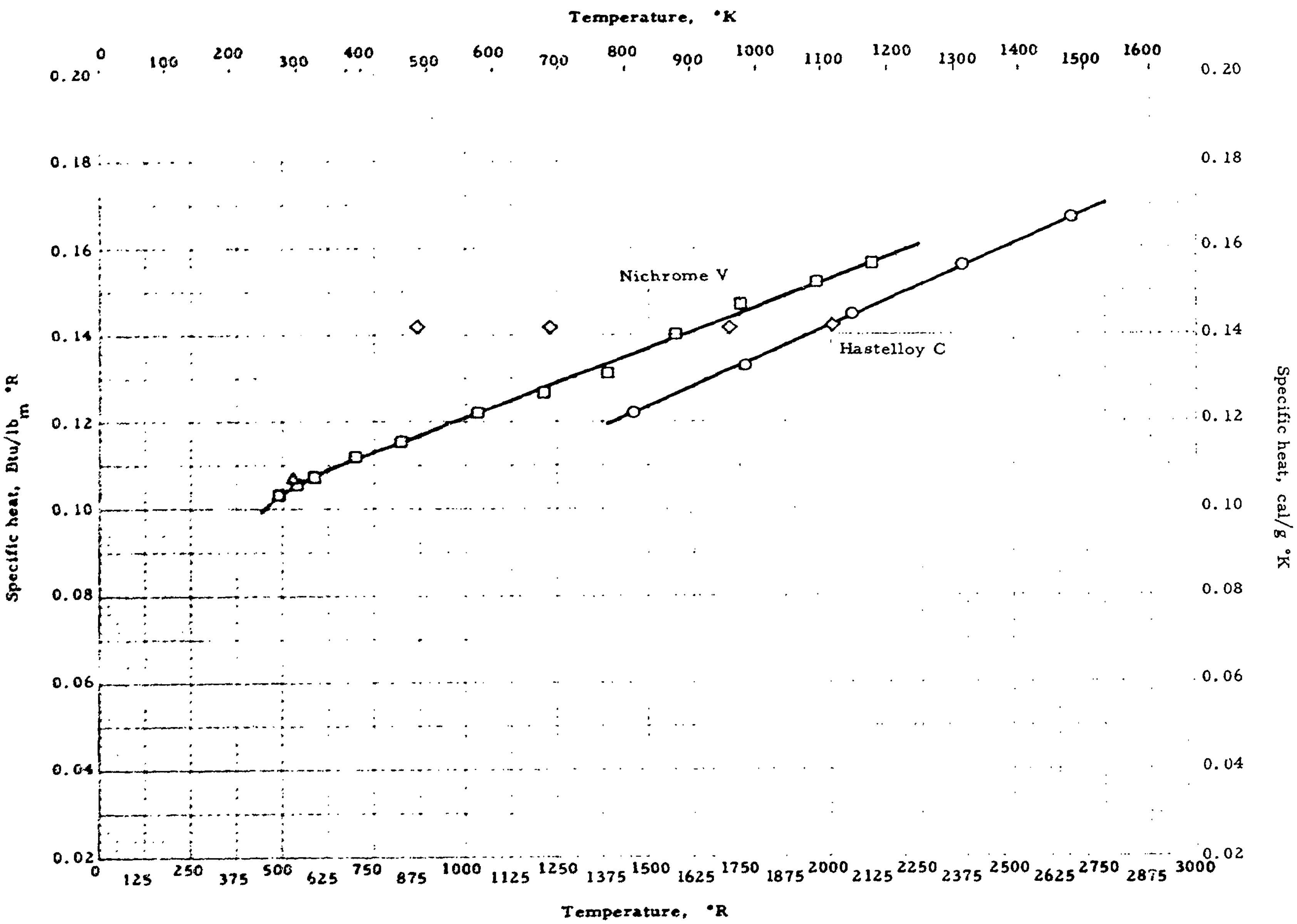
Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF NICKEL + CHROMIUM + X

REFERENCE INFORMATION

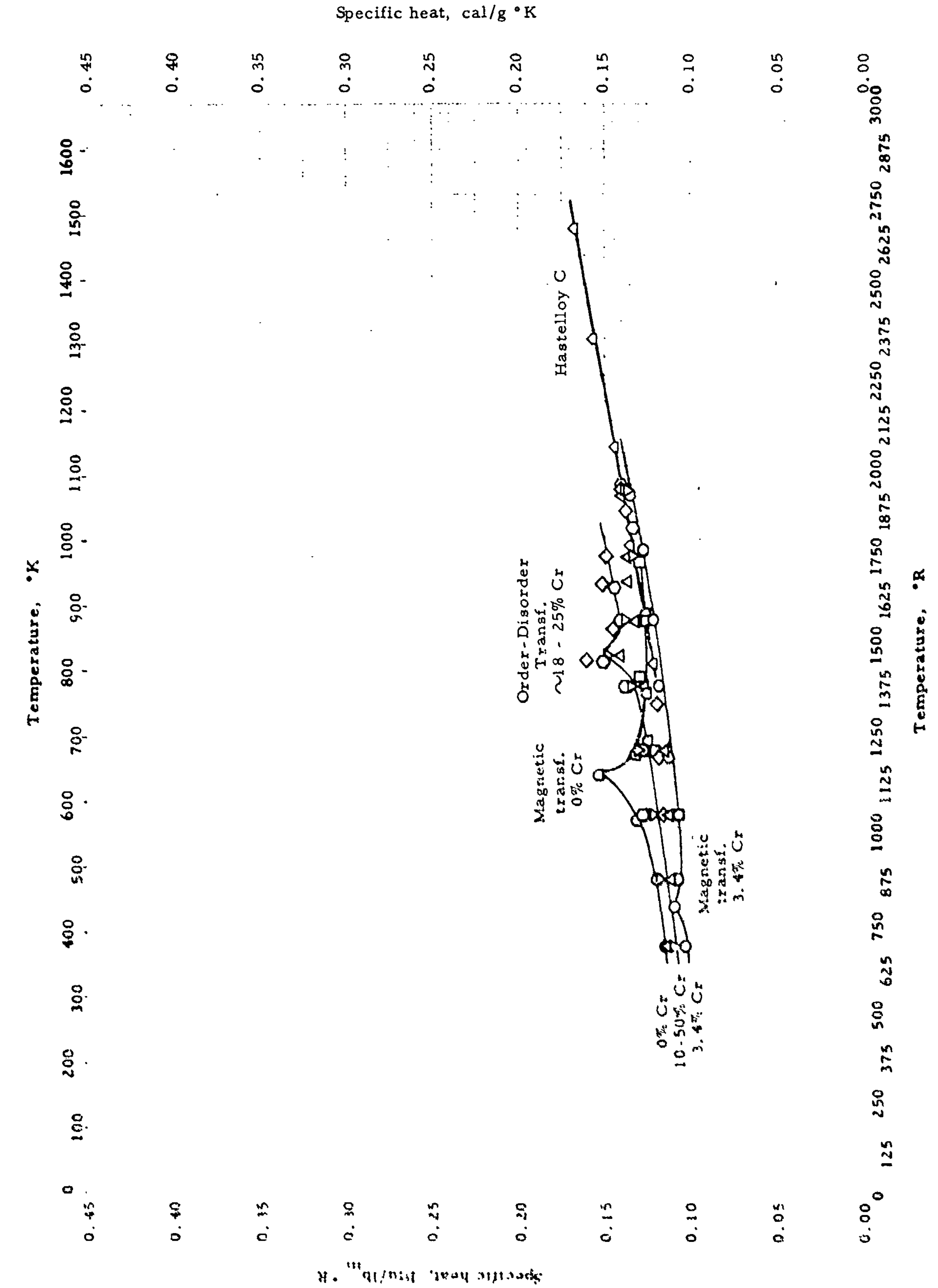
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Anon.	48-24	Room	75% Ni; 20% Cr; 2.5% Al; 2.5% Cu. "Evanohm"	ρ: not given	
□	Seibel, R. D. and Mason, G. L.	57-156	Room	79.52% Ni (by diff.); 19.33% Cr; 0.64% Si; 0.31% C; 0.17% Fe; 0.03% Mn; trace of P, nil Ti	ρ: not given	
△	Fieldhouse, I. B., Hedge, J. C., et al.	58-4	Room	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.07% C. After test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W; 0.068% C	ρ: not given	



SPECIFIC HEAT -- NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I.B., Hedge, J.C. et al.	58-4	1460-2660	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.07% C. After test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W; 0.068% C ρ = 556.9 lb_m/ft^3	Drop method; liquid calorimeter	Tested in He atmos.
□	Douglas, T.B. and Dever, J.L.	53-39 also 55-16	492-2112	Nichrome V: 77.4% Ni; 19.5% Cr; 1.4% Si; 0.59% Mn; 0.45% Fe; 0.04% C	Drop method; ice calorimeter	Auth. est. accuracy ± 2%.
△	Anon.	48-24	Room	Evanohm: 75% Ni; 20% Cr; 2.5% ea. Al, Cu	Not given	ρ = 506 lb_m/ft^3
◇	Powers, W.D. and Blalock, G.C.	53-130	871-2003	Brazing Compound. GEH 62-V: 70.3% Ni; 19.5% Cr; 11.2% Si	Drop method into ice calorimeter	Made by General Electric Co.

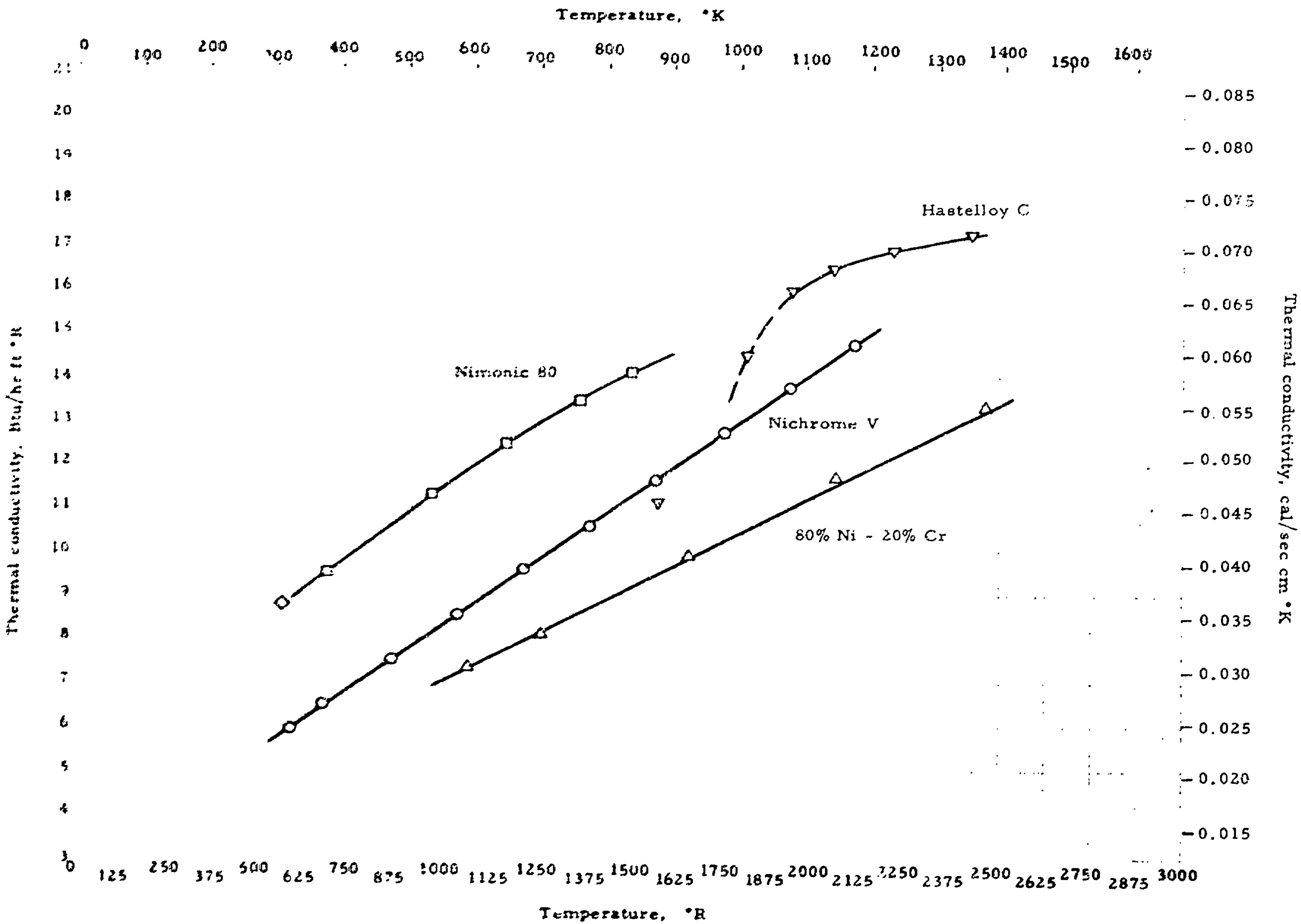


SPECIFIC HEAT -- NICKEL + CHROMIUM

SPECIFIC HEAT -- NICKEL + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
▢	Masumoto, H., Saito, H. and Takahashi, M.	54-60	672-1932	99.68% Ni; 0.28% Co; 0.017% Fe; 0.014% C; 0.006% Si; 0.001% S; traces of Mn, P	Comparative; rate of cooling of sample compared to standard (Cu) under same conditions	Cond. 1: Annealed 3 hr. at 1000°C and cooled slowly
○	Ibid.	54-60	672-1932	96.56% Ni; 3.44% Cr; prepared from Ni containing 0.28% Co; 0.017% Fe; 0.014% C; 0.006% Si; 0.001% S; traces of Mn, P; Cr containing 0.44% Si; 0.32% Fe; 0.13% Al; 0.044% C; 0.034% Mn; 0.01% S; 0.0003% P	Same as above	Same as above
□	Ibid.	54-60	1032-1932	Same as above	Same as above	Cond. 2: Annealed as above then baked for 240 hr. at 400°C and cooled slowly
△	Ibid.	54-60	672-1932	75.57% Ni; 24.43% Cr; raw materials same as above	Same as above	Cond. 1
◇	Ibid.	54-60	1032-1932	Same as above	Same as above	Cond. 2
▽	Ibid.	54-60	672-1932	50.68% Ni; 49.32% Cr; raw materials same as above	Same as above	Cond. 1
○	Ibid.	54-60	1032-1932	Same as above	Same as above	Cond. 2
△	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	1460-2660	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe, 4.41% W; 0.07% C. After test 56.00% Ni; 15.82% Cr, 14.53% Mo; 5.04% Fe; 4.49% W; 0.687% C. ρ = 556.9 lb_m/ft^3	Drop method; liquid calorimeter	

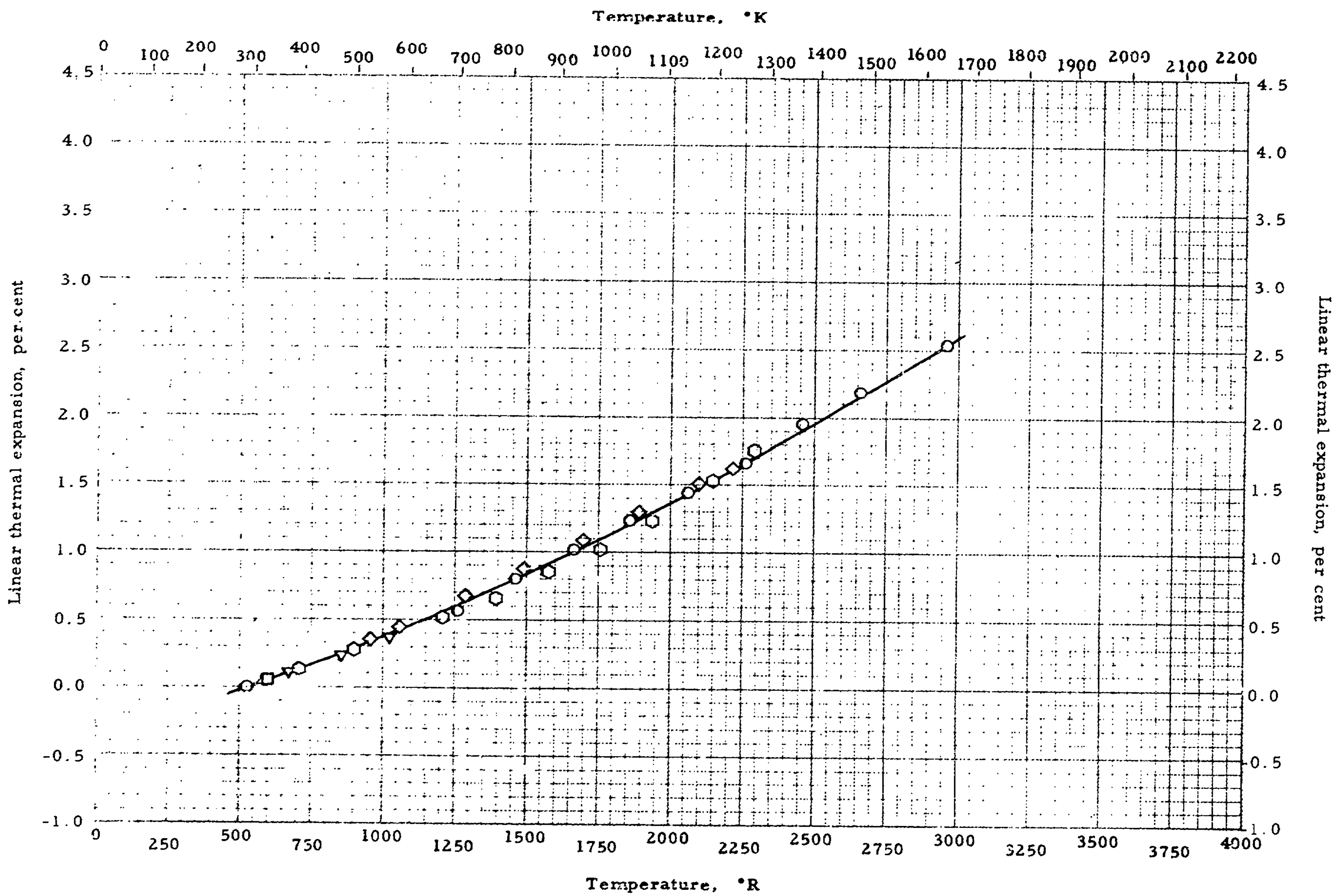


THERMAL CONDUCTIVITY -- NICKEL + CHROMIUM + X

THERMAL CONDUCTIVITY -- NICKEL + CHROMIUM + X

REFERENCE INFORMATION

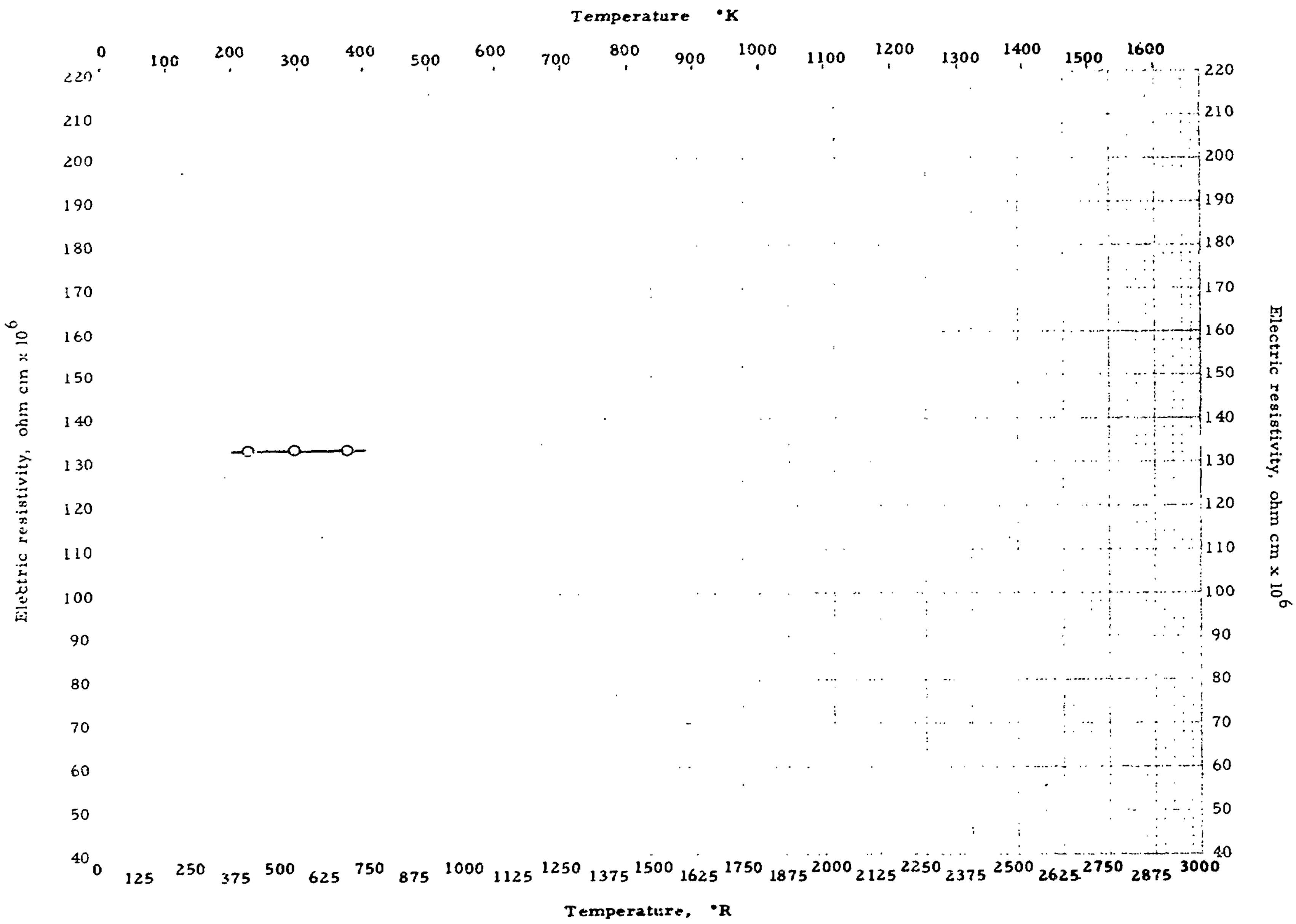
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Silverman, L.	53-2	582-2112	Nichrome V. 77.94% Ni; 19.87% Cr; 1.44% Si; 0.06% Mn; 0.036% Fe	Comparative; rods	
□	Evans Jr., J. E.	51-16	675-1500	Nimonic 80. 74.2% Ni; 21.2% Cr; 2.4% Ti; 0.63% Al; 0.04% C	Comparative; rods	Auth. est. accuracy ± 4%
△	Seibel, R.D. and Mason, G.L.	57-156	1060-2460	80 Ni - 20 Cr: 79.52% Ni (by diff.); 19.33% Cr; 0.64% Si; 0.31% C; 0.17% Fe; 0.03% Mn; Tr. of P; nil Ti	Comparative; rods, Ni standard	Auth. est. accuracy ± 10% Vacuum tested
◇	Anon.	48-24	Room	Evan ohm: 75% Ni; 20% Cr; 2.5% Al; 2.5% Cu	Not given	ρ = 506 lb_m/ft^3
▽	Fieldhouse, I.B. and Hedge, J.C.	58-4	1577-2427	Hastelloy C. Before test: 56.07% Ni; 15.83% Cr; 14.57% Mo; 4.94% Fe; 4.41% W; 0.070% C. After test: 56.00% Ni; 15.82% Cr; 14.53% Mo; 5.04% Fe; 4.49% W; 0.068% C; ρ = 557 lb_m/ft^3	Single flat plate; boiling liquid calorimeter	Noted precipitation of Ni_4Mo phase as particles between and within the grating



LINEAR THERMAL EXPANSION -- NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Seibel, R. D. and Mason, G. L.	57-156	1260-2960	79.52% Ni (by diff.); 19.33% Cr; 0.64% Si; 0.31% C; 0.17% Fe; 0.03% Mn; Trace of P; Nil Ti	Alumina tube dilatometer with differential transformer pick-up. Tested in vac.	
□	Hidnert, P.	57-134	600	Evanohm: 75.0% Ni; 20.0% Cr; 2.5% ea Cu, Al	Not described here, refers to others	Drawn to wire
▽	Ibid.	57-134	672-1032	Illium Alloy: 59.0% Ni; 24.0% Cr; 7.0% Cu; 4.0% Mo; 2.0% W; 1.5% ea Mn, Si; 1.0% Ag	Not described here, refers to others	Cast
○	Ibid.	57-134	672-2292	Waspalloy: 55.45% Ni; 19.22% Cr; 11.20% Co; 7.00% Mo; 2.49% Ti; 1.03% Al; 0.73% Fe; 0.67% Mn; 0.47% Si; 0.45% C; 0.12% Cu; 0.015% P; 0.008% S	Same as above	Annealed 3 hr. at 1000°C in pure dry H_2, furnace cooled at 150°C/hr. from 1000°C to 600°C, then 85°C/hr. to 20°C. Auth. also gives 2nd heating & 2nd cooling data to 1212°R identical to that of 1st heating
△	Anon.	48-24	582	Evanohm: 75% Ni; 20% Cr; 2.5% ea Cu, Al	Not given	ρ = 510 lb_m/ft^3
◇	Saller, H. A. et al.	53-127	960-2260	GE-62 Brazing alloy (similar to J-8100) Nominal: 69% Ni; 20% Cr; 11% Si	Recording dilatometer tested in vac.	Arc melted, cast, heat treated 24 hr. at 1800°F in vac. Data are avg. of 2 complete heating & cooling cycles, also gives data for samples in as-cast condition

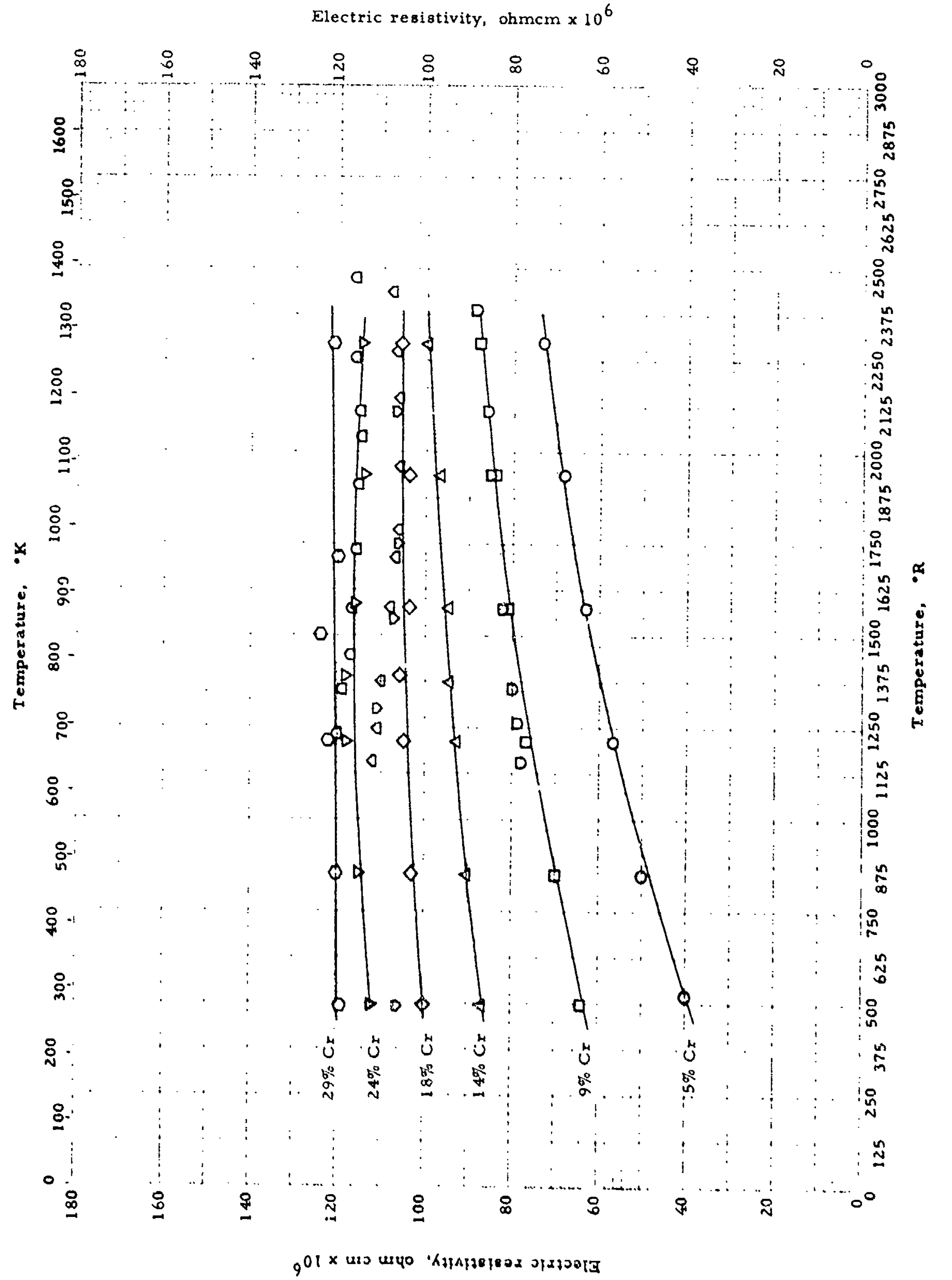


ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM + X

ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Anon.	48-24	400-675	Evanohm: 75% Ni; 20% Cr; 2.5% Al; 2.5% Cu	Not given	$\rho = 506\ lb_m/ft^3$

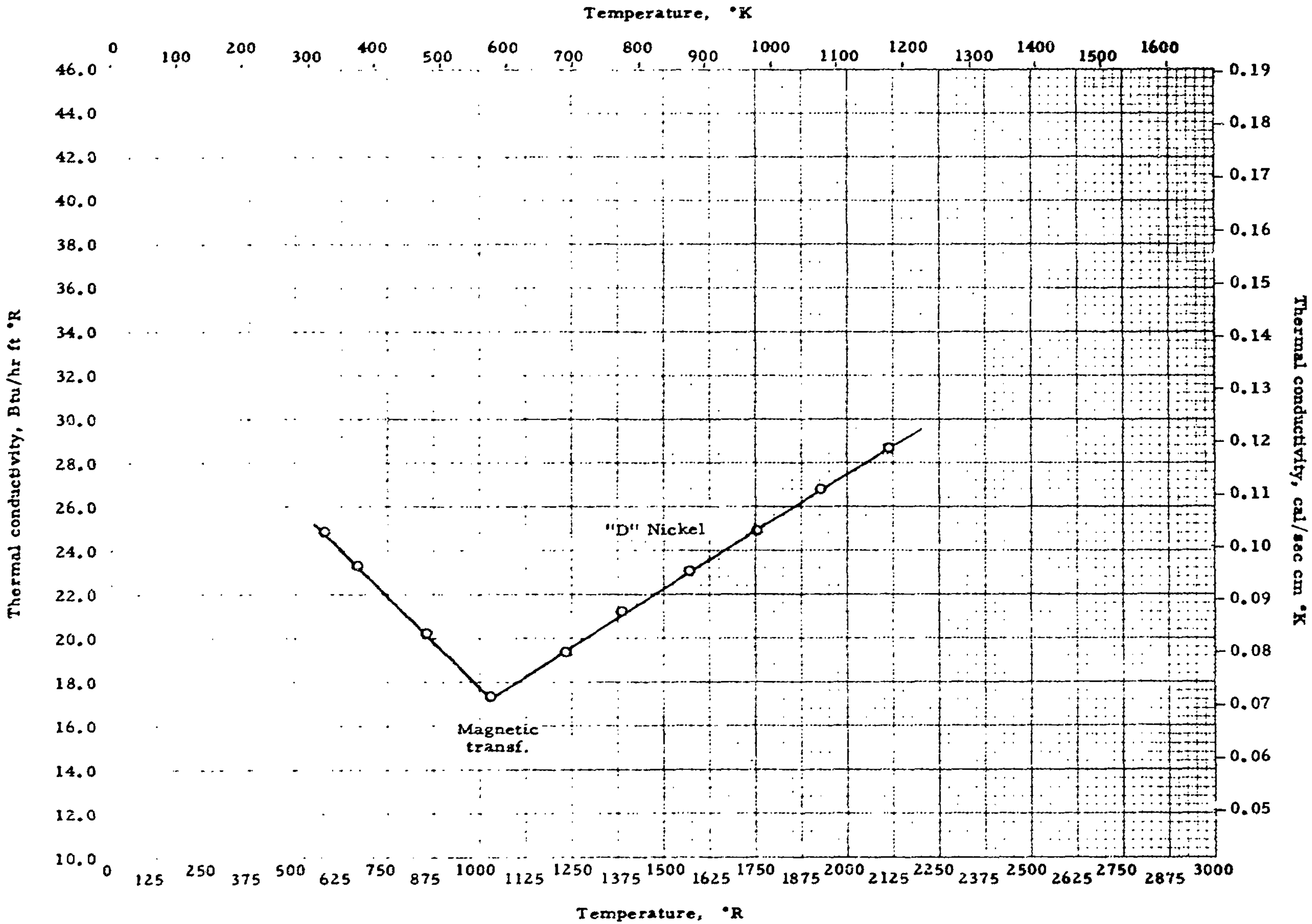


ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM

ELECTRIC RESISTIVITY -- NICKEL + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Thomas, H.	51-43	528-2292	Nominal: 95.15% Ni; 4.85% Cr	Self-registering device with automatic plotting of r vs. temp. low accuracy	Vacuum melted, forged, rolled, cold drawn into 0.4 mm wires
□	Ibid.	51-43	528-2292	Nominal: 90.8% Ni; 9.2% Cr	Same as above	Same as above
△	Ibid.	51-43	528-2292	Nominal: 85.6% Ni; 14.4% Cr	Same as above	Same as above
◇	Ibid.	51-43	528-2292	Nominal: 81.9% Ni, 18.1% Cr	Same as above	Same as above
▽	Ibid.	51-43	528-2292	Nominal: 76% Ni; 24% Cr	Same as above	Same as above
○	Ibid.	51-43	528-2292	Nominal: 71.1% Ni; 28.9% Cr	Same as above	Same as above
⌂	Nordheim, R. and Grant, N. J.	54-23	1230-2472	70.6% Ni; 29.4% Cr	Kelvin Double Bridge	Prepared from Mond Ni and electrolytic Cr. Chromium annealed at 1250°C in H_2 atmos. for 100 hr. to decrease O_2 and C content; Resistivities are equlibrium values
△	Ibid.	54-23	1158-2436	79.8% Ni; 20.2% Cr; 0.03% O_2, 0.005% N_2; 0.002% C; 0.002% S	Same as above	Same as above
□	Ibid.	54-23	1158-2382	90.2% Ni; 9.8% Cr	Same as above	Same as above
▽	Köster, W. and Rocholl, P.	57-160	492-2112	18.1% Cr; <0.6% Mn; <0.3% Si	Potential drop	50% cold reduced by rolling. Tempered 7 days at 435°C. Auth. est. accuracy ± 0.1%

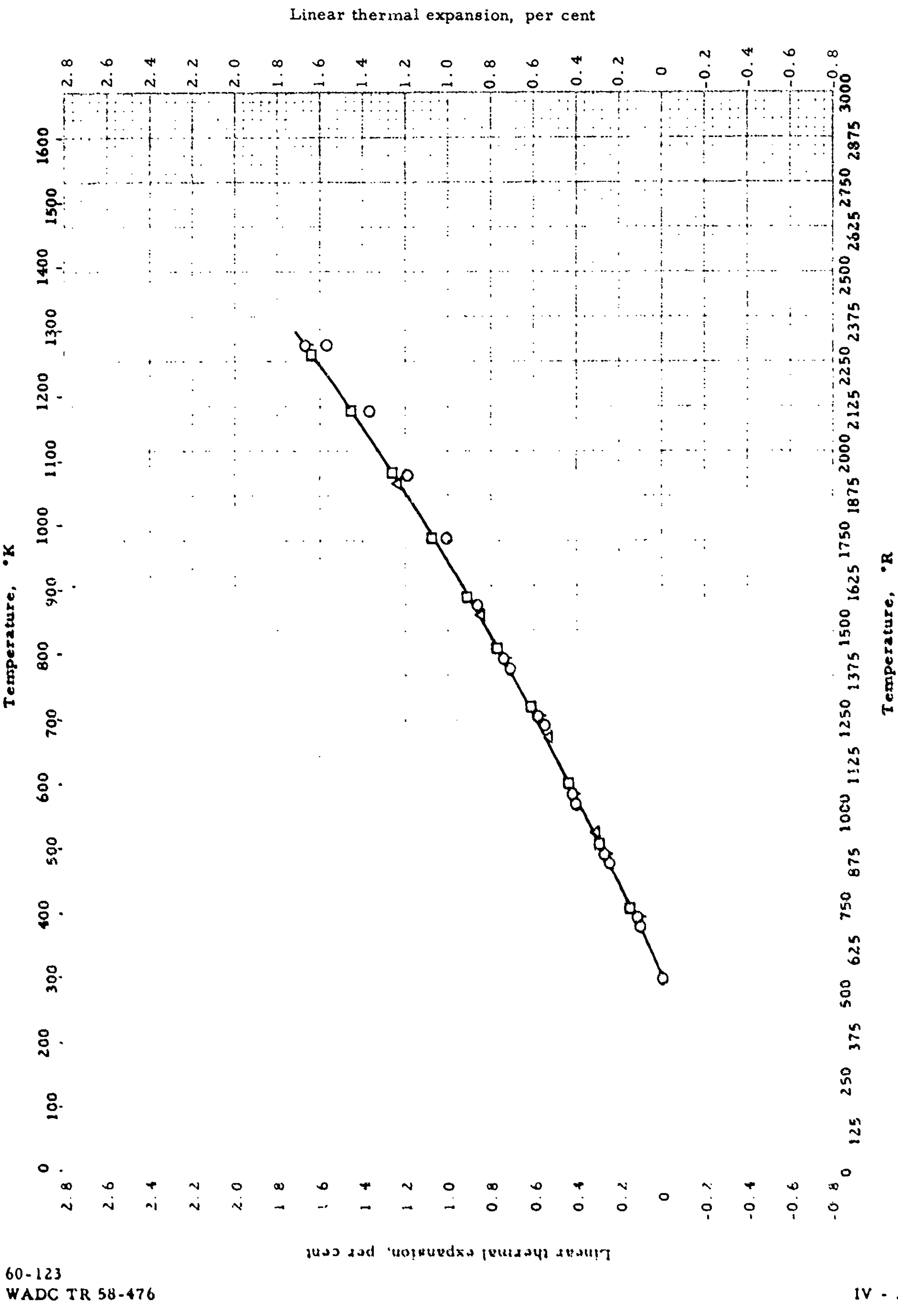


THERMAL CONDUCTIVITY -- NICKEL + MANGANESE + X

THERMAL CONDUCTIVITY -- NICKEL + MANGANESE + X

REFERENCE INFORMATION

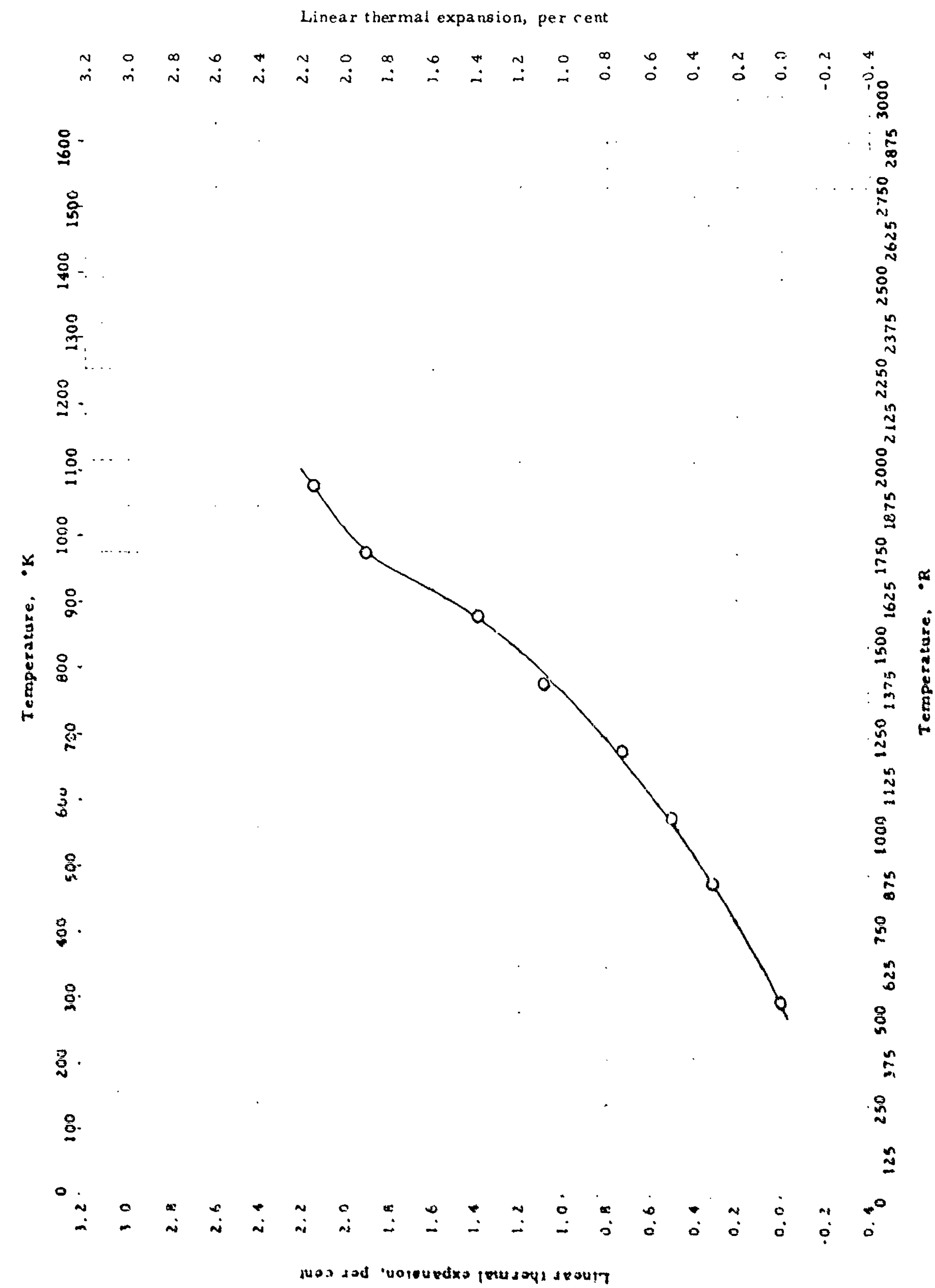
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Silverman, L.	53-2	582-2112	"D" Nickel. 92.79% Ni; 4.35% Mn; 1.35% Fe; 1.27% Co; 0.158% C; 0.06% Si	Comparative; rods	



LINEAR THERMAL EXPANSION -- NICKEL + MANGANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P.	57-134	672-2292	Haskins alloy 667: 94.5% Ni, 3.9% Mn, 0.81% Si, 0.04% C	Micrometric apparatus of NBS 436	Cast, hot rolled to 1/4 in. diameter, cooled in air. ○ - first heating ♀ - cooling
□	Ibid.	57-134	672-2292	Same as above	Same as above	Same as above, second heating
△	Ibid.	57-134	852-1932	Manganese nickel: 97.0% Ni, 1.6% Mn, 0.8% Fe, 0.3% Cu	Same as above	Drawn to wire

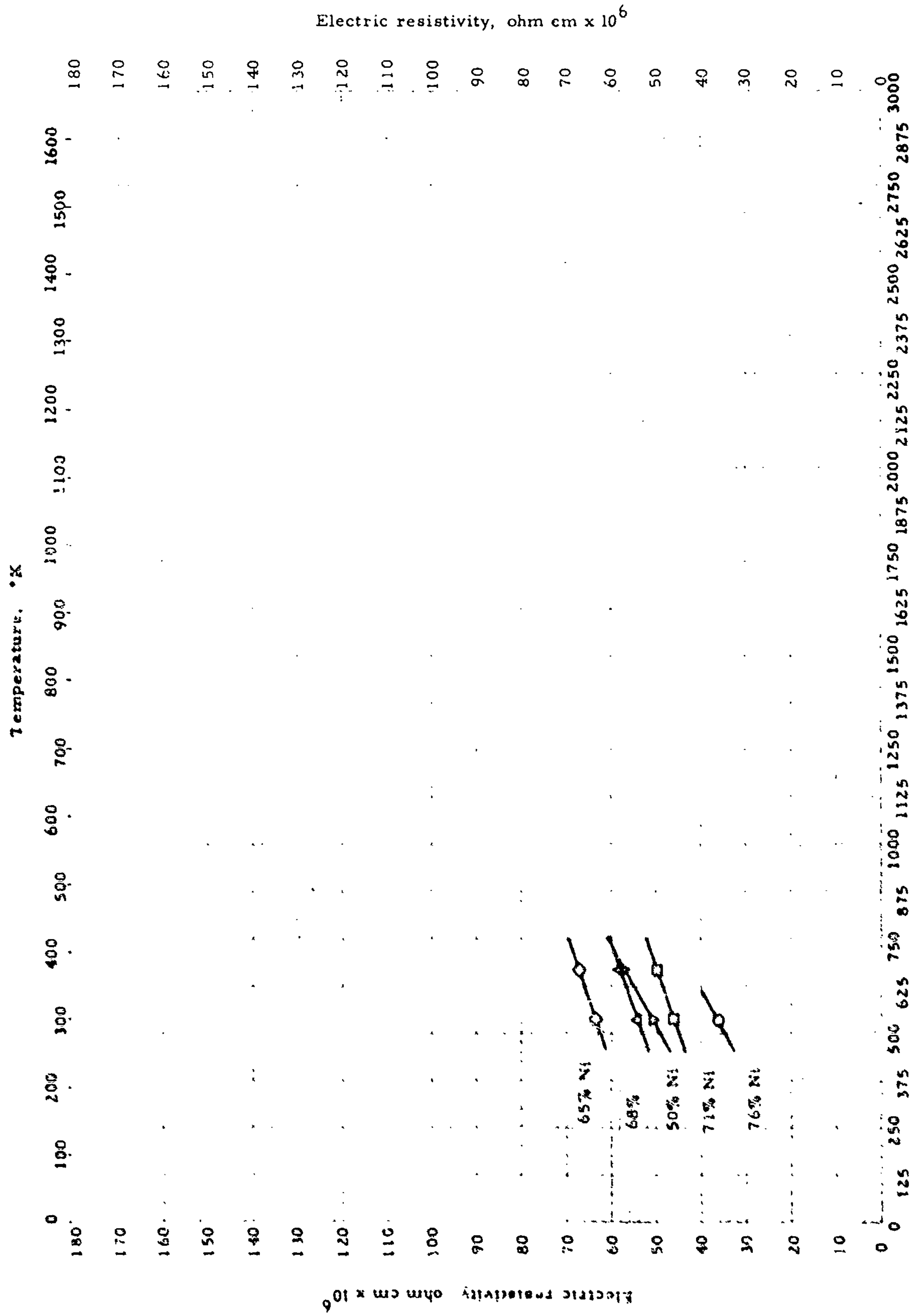


LINEAR THERMAL EXPANSION -- NICKEL + MANGANESE

LINEAR THERMAL EXPANSION -- NICKEL + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mokhov, V. M., Agladze, R. I. and Topuaridshvili, L. I.	55-56	524-1932	50.6% Ni; 49.4% Mn. Prepared from electrolytic purity metals	Dilatometer	Quenched, homogenized

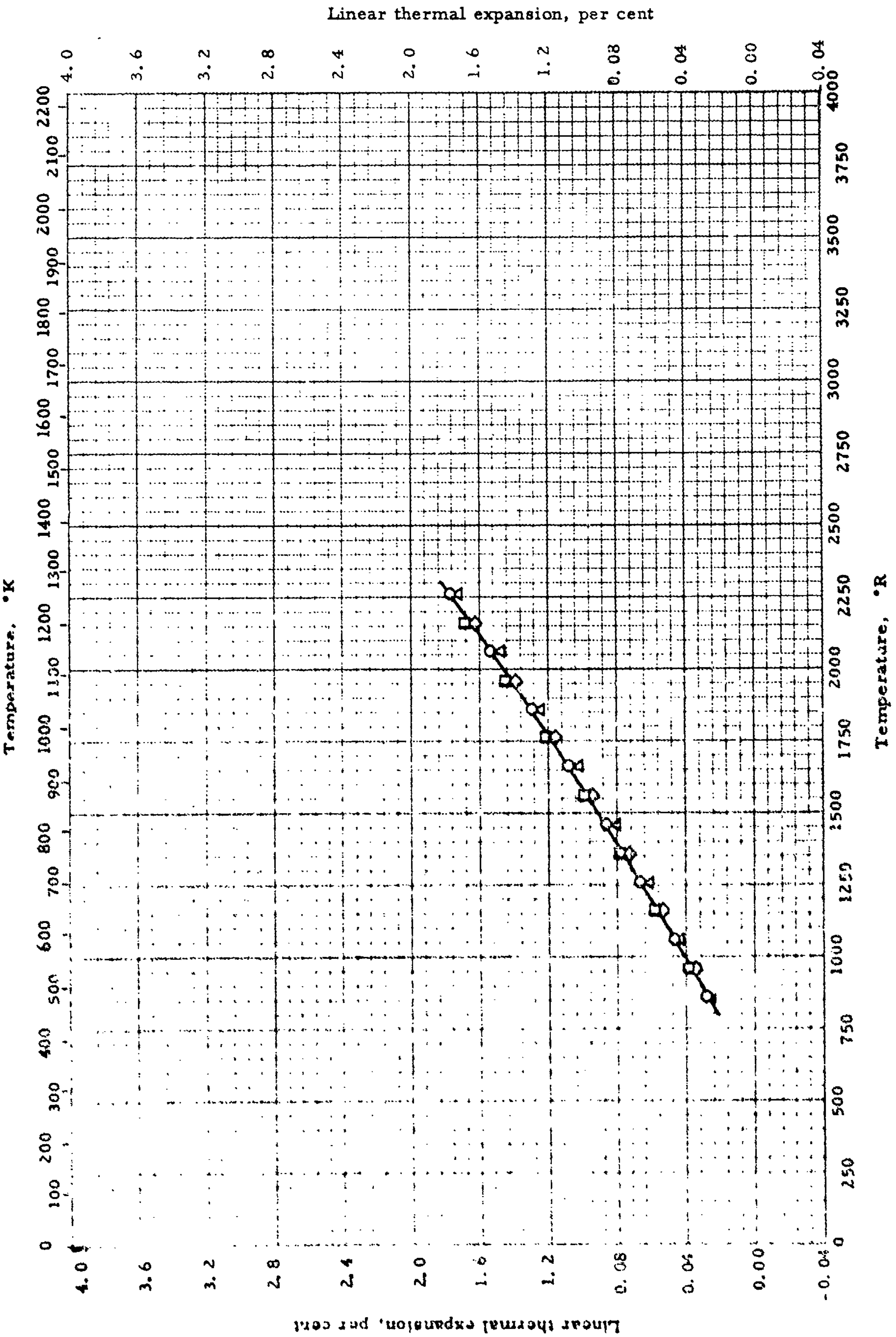


ELECTRIC RESISTIVITY -- NICKEL + MANGANESE

ELECTRIC RESISTIVITY -- NICKEL + MANGANESE

REFERENCE INFORMATION

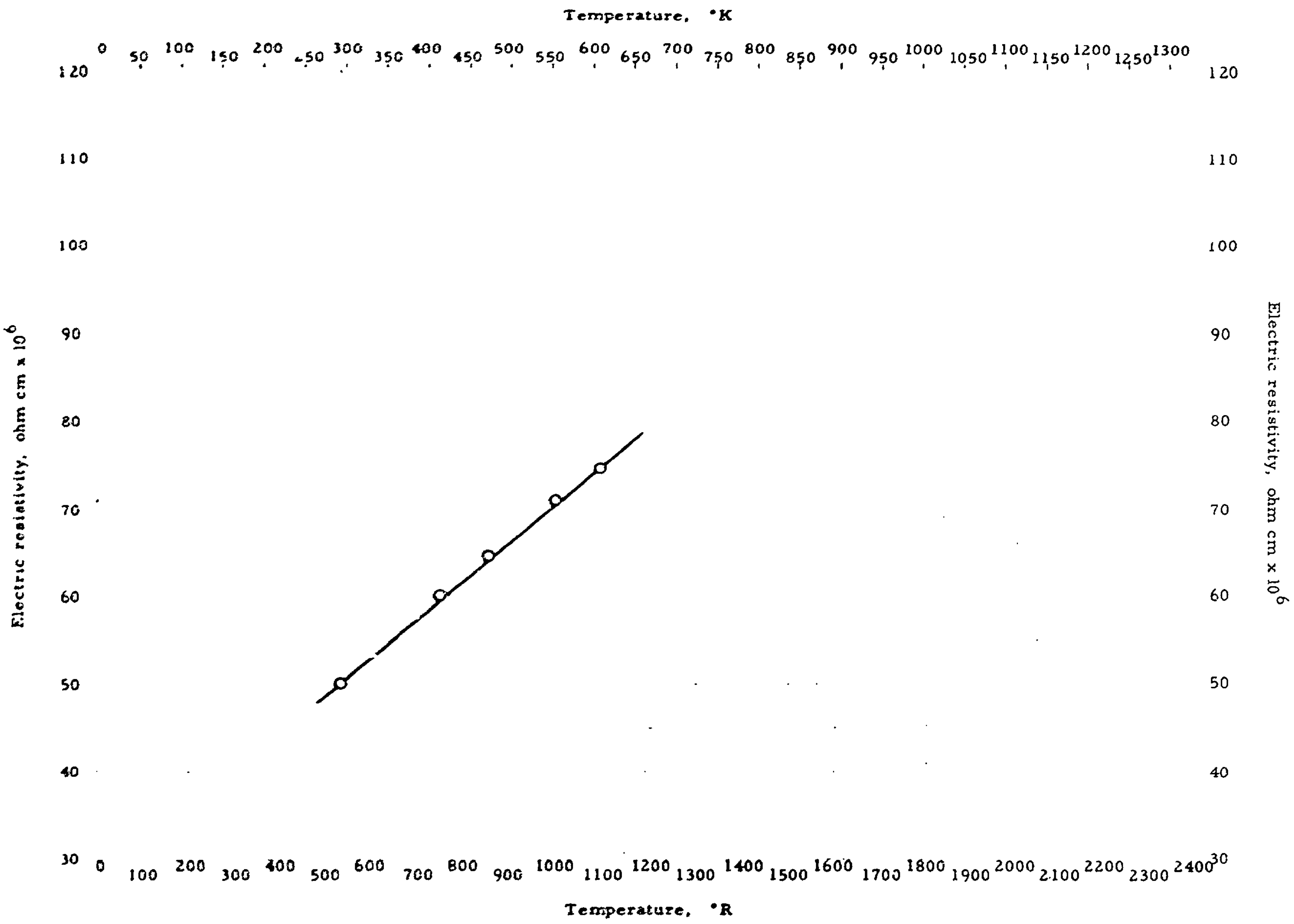
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kurnakov, N. N. and Troneva, M. Ya.	49-32	537-672	75.89% Ni	Thompson bridge	Made from electrolytic Mn and Ni in alumina crucibles in an induction furnace. Annealed in steps from 980°C to 500°C, the entire process lasting 5 days
□	Ibid.	49-32	537-672	71.39% Ni	Same as above	Same as above
△	Ibid.	49-32	537-672	69.49% Ni	Same as above	Same as above
◇	Ibid.	49-32	537-672	66.39% Ni	Same as above	Same as above
▽	Ibid.	49-32	537-672	5[illegible].90% Ni	Same as above	Same as above



LINEAR THERMAL EXPANSION -- NICKEL + PALLADIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A., Stacy, J. T. and Klebanow, H. L.	54-116	860-2260	44.75% Ni; 33% Pd; 22.25% Cr; 0.04% Si; 0.01% S	Recording dilatometer	Made from 75% GE-76 brazing alloy and 25% Nichrome V. Auth. est. accuracy ± 2%. As cast
□	Ibid.	54-116	860-2260	Same as above	Same as above	Same as above, then heat treated 24 hr. at 2000°F in argon atm.
△	Ibid.	54-116	860-2260	56.5% Ni; 22% Pd; 21.5% Cr; 0.025% Si; 0.007% S	Same as above	Made from 50% Ge-76 brazing alloy and 50% Nichrome V. Auth. est. accuracy ± 2%. As cast
◇	Ibid.	54-116	860-2260	Same as above	Same as above	Same as above. Heat treated 24 hr. at 2000°F in argon atm.

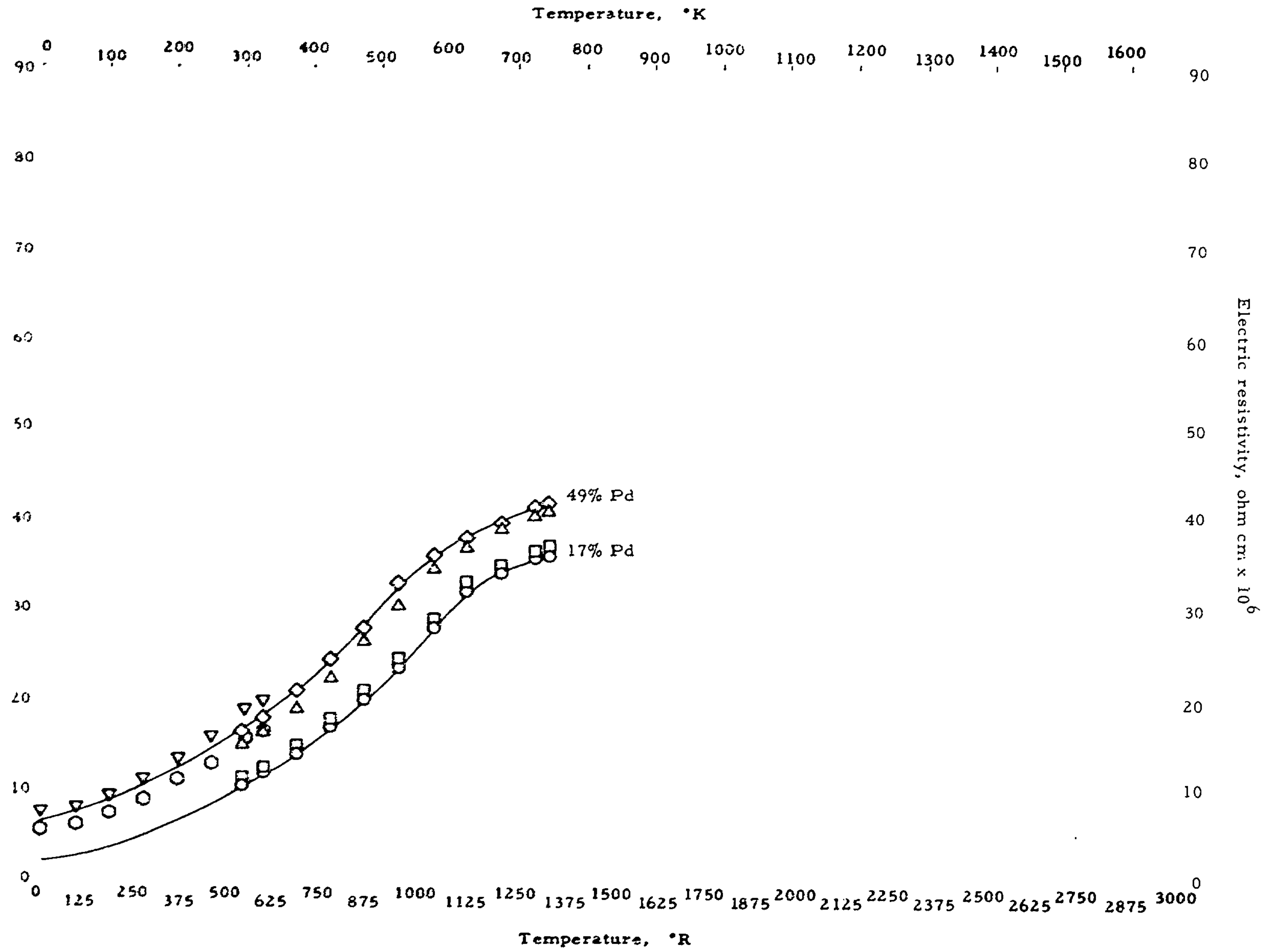


ELECTRIC RESISTIVITY -- NICKEL + ALUMINUM

ELECTRIC RESISTIVITY -- NICKEL + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Liu, T.S. and Bobone, R.	54-124	528-1091	86.2% Ni; 13.8% Al	Not given	Prepared from 99.89% pure Mond carbonyl process Ni with <0.10% C; <0.001% Co and 99.99% pure Al with 0.001% ea. Cu, Fe, Si and 0.000% Mg. Heat treated 72 hr. at 1100°C, furnace cooled. Auth. also reports data for numerous other alloys

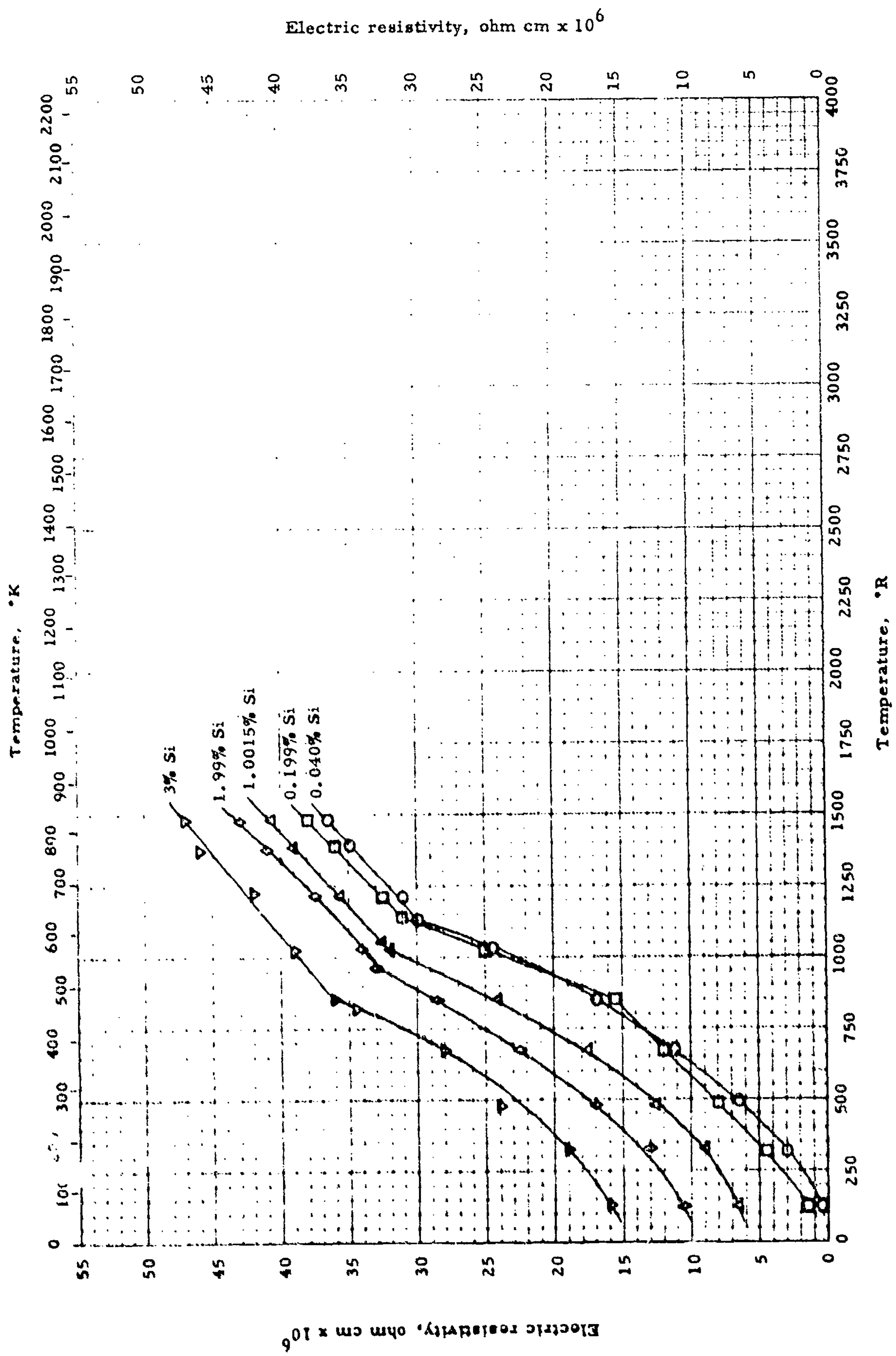


ELECTRIC RESISTIVITY -- NICKEL + PALLADIUM

ELECTRIC RESISTIVITY -- NICKEL + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Schindler, A. I., Smith, R. J. and Salkovitz, E. I.	57-18 also 57-27	528-1338	83.04% Ni; 16.96% Pd	Kelvin bridge	Annealed 2 hr. at 1070°K in vacuum, furnace cooled 24 hr. Tested in vacuum
□	Ibid.	57-18 also 57-27	528-1338	81.04% Ni; 18.96% Pd	Same as above	Same as above
△	Ibid.	57-18 also 57-27	528-1338	60.77% Ni; 39.23% Pd	Same as above	Same as above
◇	Ibid.	57-18 also 57-27	528-1338	51.08% Ni; 48.92% Pd	Same as above	Same as above
▽	Schindler, A. I., Smith, R. J. and Salkovitz, E. I.	56-16	0-585	60.77% Ni, 39.23% Pd	Kelvin bridge	Annealed 2 hr. at 1070°K in vacuum, furnace cooled 24 hr.



ELECTRIC RESISTIVITY -- NICKEL + SILICON

ELECTRIC RESISTIVITY -- NICKEL + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Domenicali, C.A. and Otter, F.A	55-7	132-1482	0.040% Si	Potential drop	Alloy prepared from 99.9% pure Ni and 99.95% pure Si homogenized 6-10 hr. just below M.P.
□	Ibid.	55-7	132-1482	0.199% Si	Same as above	Same as above
△	Ibid.	55-7	132-1482	1.0015% Si	Same as above	Same as above
♀	Ibid.	55-7	132-1482	1.99% Si	Same as above	Same as above
▽	Ibid.	55-7	132-1482	3.00% Si	Same as above	Same as above

Symbol	Material (for Analysis see Reference Information)	Density		Melting Point	
		lb_m/ft^3	g/cm^3	°R	°K
○	Vitallium			3039	1638
□	Stellite No. 21	518*	8.30*		
◁	Stellite No. 21	511	8.19		
△	Stellite No. 23	533	8.54		
◇	Haynes alloy No. 25	571	9.15		
▽	Stellite No. 30	519	8.31		
⬡	Stellite No. 31	538*	8.61*		
◻	Stellite No. 31	504	8.08		
▽	Stellite No. 31	537	8.60		
◠	Haynes alloy No. 36	564	9.04		
◺	64 Co - 30 Cr - 6 W sint. alloy	526	8.44		
△	64 Co - 30 Cr - 6 W sint. alloy			3048	1693
◇	Jessop G32	515	8.26		

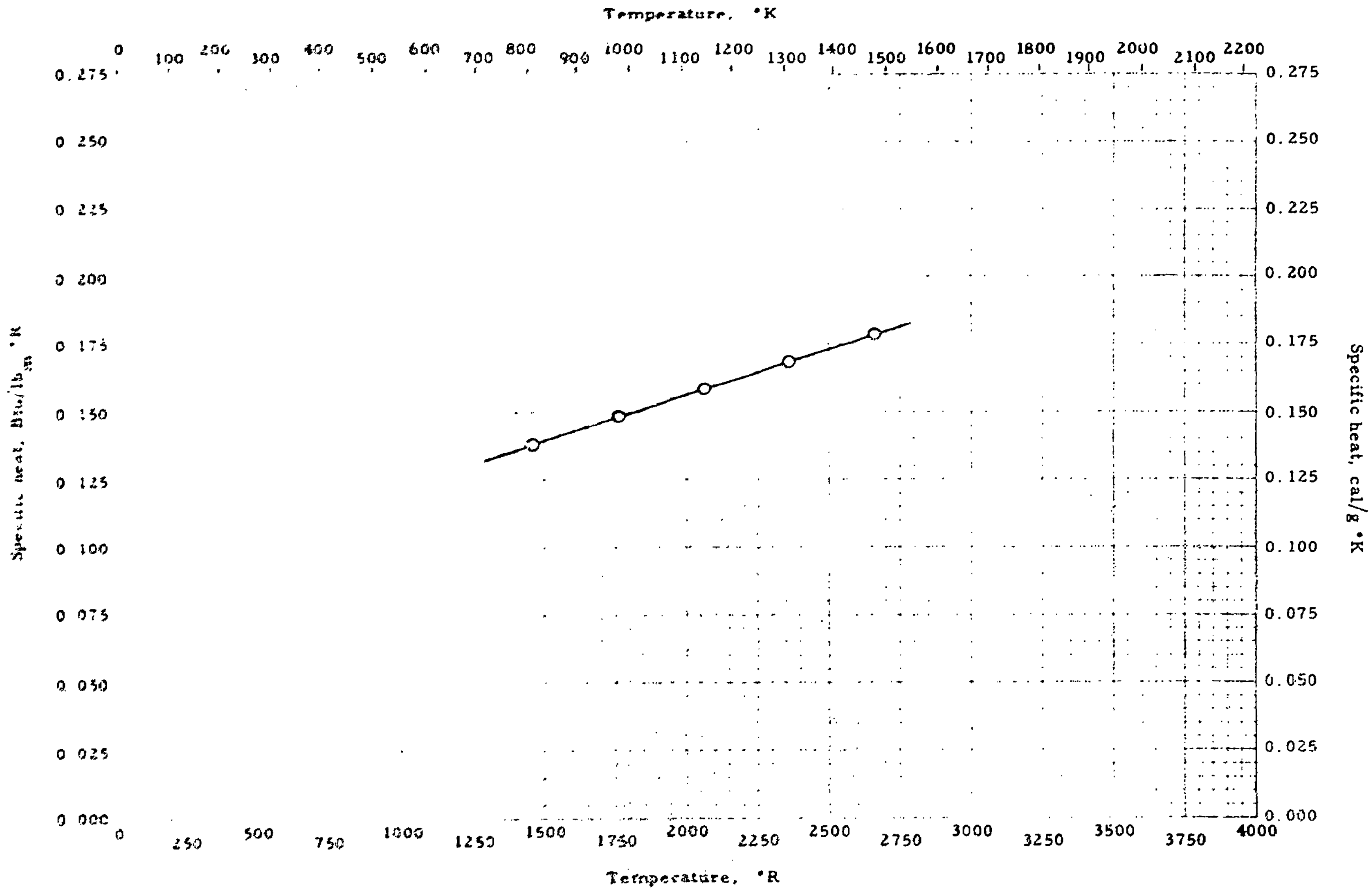
* Most probable value.

PROPERTIES OF COBALT + CHROMIUM + X

PROPERTIES OF COBALT + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Allegro, R. A., Coffin, L. B. and Tinklepaugh, J. R.	[illegible]	[illegible]	Vitallium, 25-35% Cr, 4.5-6.5% Mo, 1.5-3.5% Ni; < 2% Fe, 0.2-0.35% C	MP: collapse of hole in disk	Vitallium reacted with SiC support; tested in vacuum (0.044 mm Hg)
□	Sweeney, W. O.	50-14 also 47-14	Room	Stellite No. 21 (AMS No. 5385; NDRC No. NR-10) nominal, 25-30% Cr, 4.5-6.5% Mo, 1.5-3.5% Ni, < 2% Fe, 0.2-0.35% C	ρ: not given	Tested by Battelle Memorial Institute for N. D. R. C.
△	Ibid.	50-14 also 47-14	Room	Stellite No. 23 (AMS 5375, NDRC-61) 23-29% Cr; 4-7% W, < 2% Fe, < 1.5% Ni; 0.35-0.5% C	ρ: not given	Same as above
◇	Ibid.	50-14 also 47-14	Room	Haynes Alloy No. 25 (L-605, nominal, 19-21% Cr, 14-16% W, 9-11% Ni; 1-2% Mn, < 2% Fe, < 1% Si, < 0.15% C	ρ: not given	
▽	Ibid.	50-14 also 47-14	Room	Stellite No. 30 (AMS-5380, NR-12) nominal, 23-29% Cr, 13-17% Ni, 5-7% Mo, < 2% Fe, 0.35-0.50% C	ρ: not given	Tested by Battelle Memorial Institute for N. D. R. C.
○	Ibid.	50-14 also 47-14	Room	Stellite No. 31 (AMS No. 5382; NR-71) nominal; 23-26% Cr, 9-12% Ni, 6-9% W, < 2% Fe; 0.45-0.60% C	ρ: not given	Same as above
⌂	Ibid.	50-14 also 47-14	Room	Haynes Alloy No. 36 (L-251) nominal, 17.5-19.5% Cr, 14-15% W, 9-11% Ni, < 2% Fe; 1-1.5% Mn; 0.35-0.65% Si, 0.35-0.45% C, 0.01-0.05% B	ρ: not given	Tested at Haynes Stellite Co. laboratories
⌂	Boswell, R. W. A., Pitkin, W. R. and Jenkins, I.	52-29	3044	Sintered alloy; nominal; 30% Cr, 6% W	MP: not given	Powders mixed 15 hr., pressed at 70,000 psi, sintered 8 hr. at 1325°C in dry H_2 atmos.
△	Ibid.	52-28	Room	Same as above	ρ: not given	Same as above
▽	Willmore, T. A. and Bennett, D. G.	55-118	Room	Haynes Stellite 31 = X-40. Nominal 23 - 28% Cr; 9 - 12% Ni, 6 - 9% W, 2% Fe max, 0.45 - 0.60% C	ρ: not given	Prepared like a cermet. Compacted at 60,000 psi with camphor, sintered 30 min. at 2500°F
▽	Ibid.	55-118	Room	Same as above	ρ: not given, probably computed from X-ray measurements of lattice	
○	Oliver, D. A. and Harris, M. A.	52-25	Room	Jessop G32 alloy (British desig.): 46.6% Co, 19.1% Cr, 19.5% Ni, 3.0% V; 2.2% Mo, 1.4% Nb; 0.77% Mn, 0.52% Si, 0.27% C	ρ: not given	
▽	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	Room	Stellite 21: 60.49% Co, 26.69% Cr, 5.42% Mo; 2.38% Ni, 1.54% Fe, 0.258% C	ρ: not given	

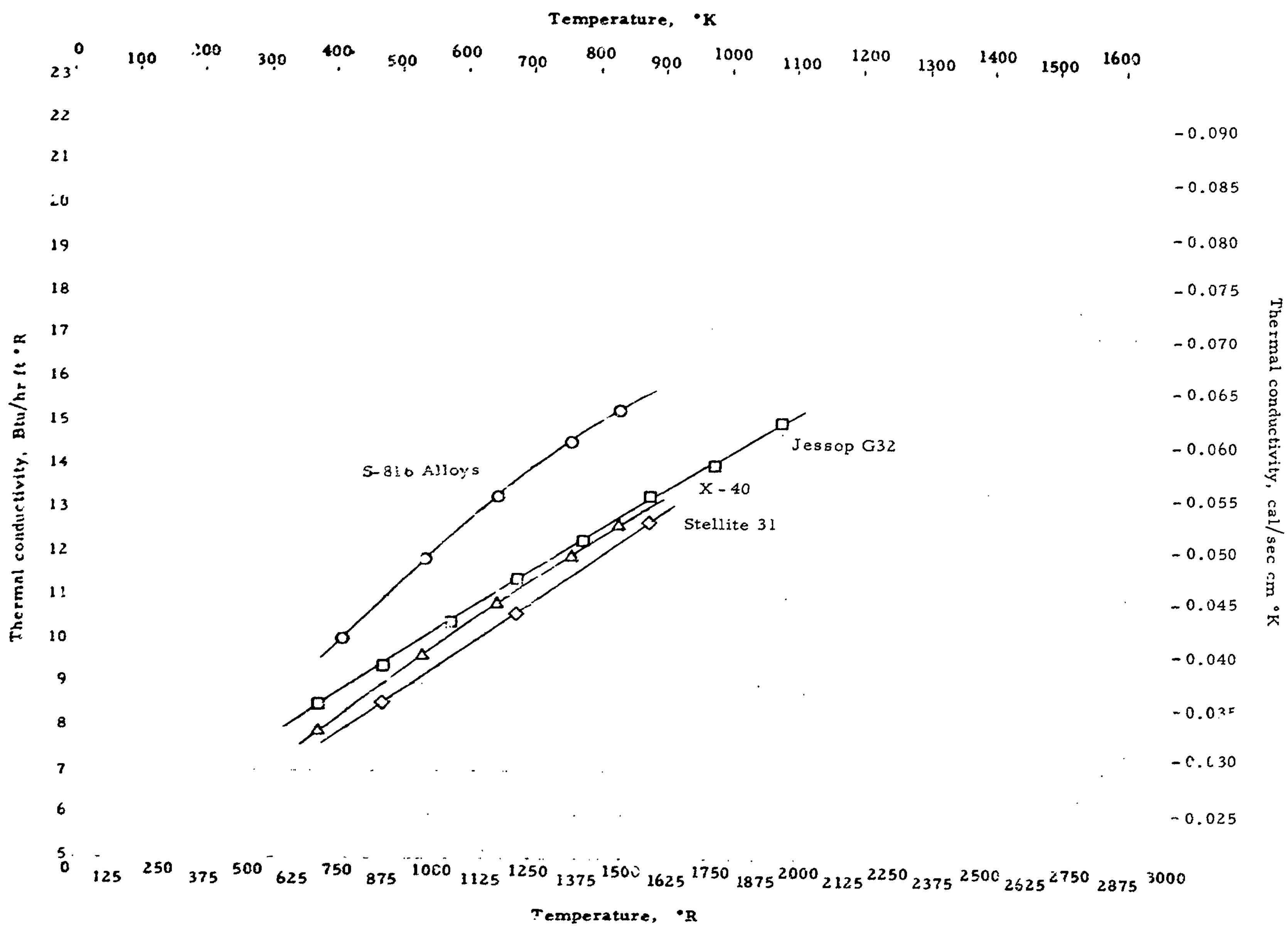


SPECIFIC HEAT -- COBALT + CHROMIUM + MOLYBDENUM + X

SPECIFIC HEAT -- COBALT + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	1460-2660	Stellite 21. Before test: 60.49% Co; 26.69% Cr; 5.42% Mo; 2.38% Ni; 1.54% Fe; 0.258% C. After test: 62.27% Co; 26.74% Cr; [illegible].42% Mo; 2.42% Ni; 1.23% Fe; 0.264% C. $\rho = 511.2\ lb_m/ft^3$	Drop method; liq. calorimeter	

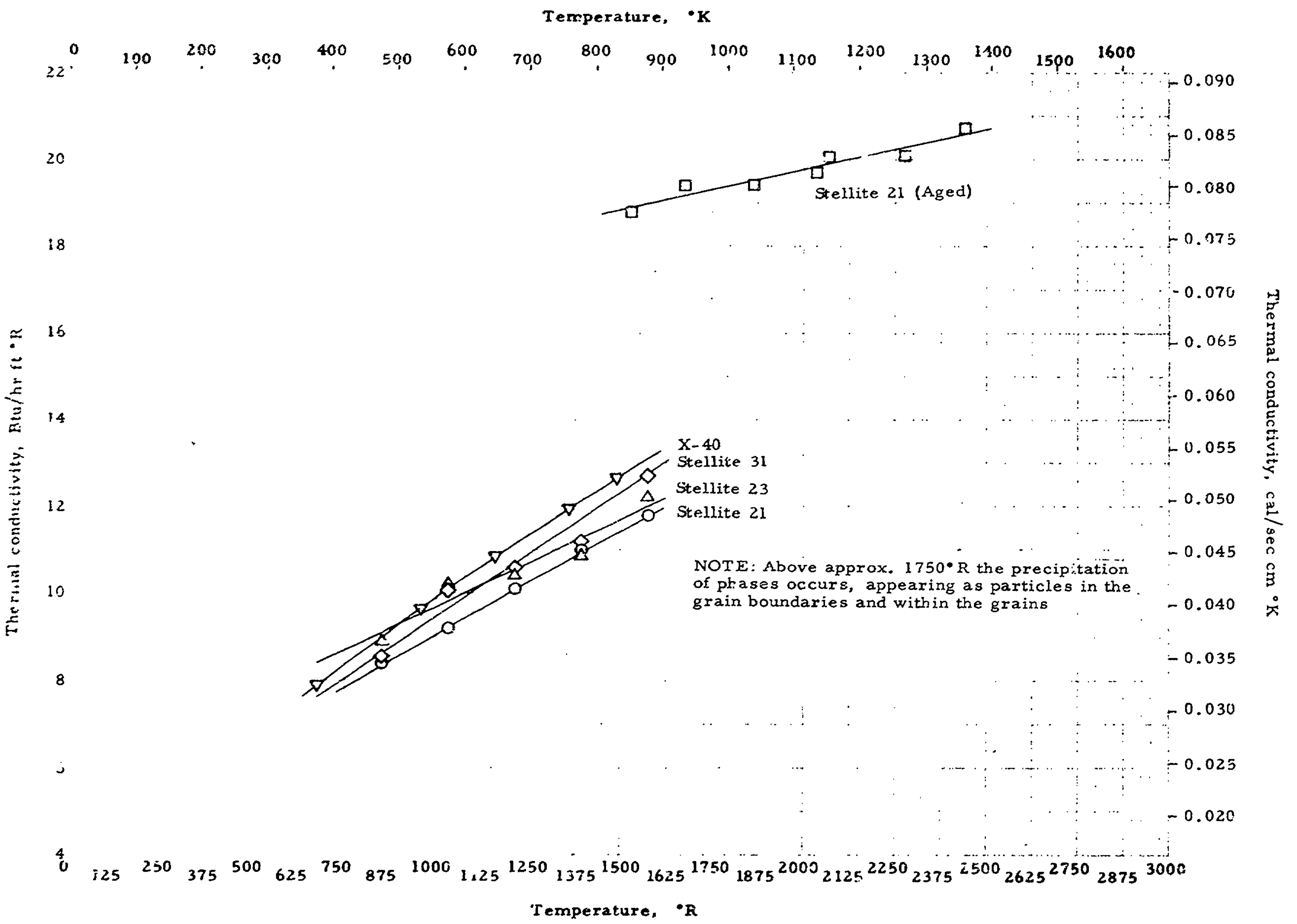


THERMAL CONDUCTIVITY -- COBALT + CHROMIUM + NICKEL + X

THERMAL CONDUCTIVITY -- COBALT + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

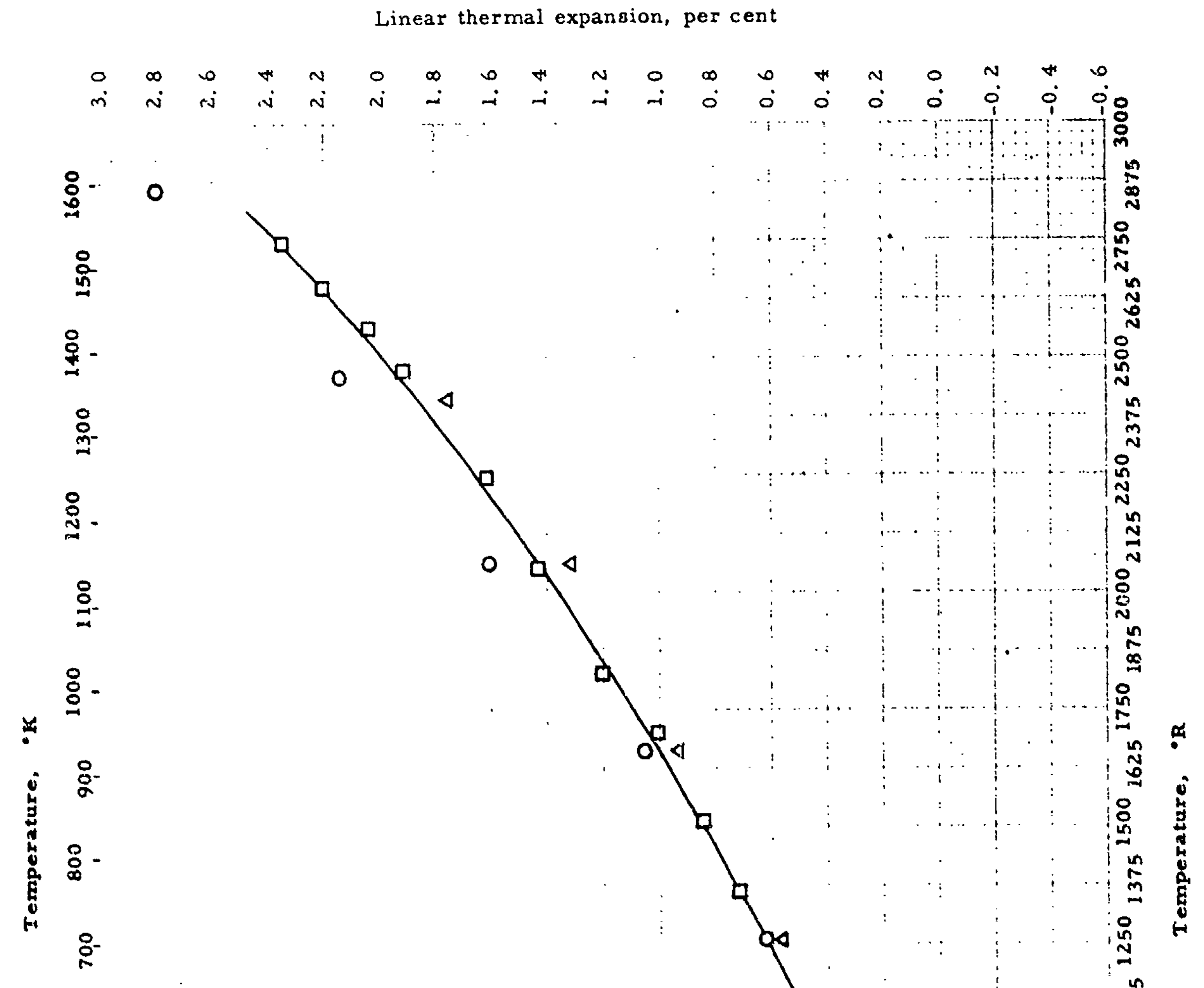
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Evans Jr., J. E	51-16	735-1490	S-816: 45.0% Co; 20.0% Ni; 20.0% Cr; 15.0% Fe (by difference)	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%
□	Oliver, D. A. and Harris, M. A.	52-25	528-1932	Jessop G32 Steel (Brit. Desig.): 46.6% Co; 19.1% Cr; 10.5% Ni; 3.0% V; 2.2% Mo; 1.4% Nb; 0.77% Mn; 0.52% Si; 0.27% C; ρ = 515 lb_m/ft^3	Not given	
△	Evans Jr., J.E.	51-16	675-1490	X-40: 25.5% Cr; 10.5% Ni; 7.5% W; 2.0% Fe, 0.53% C	Comparative; rods with Pb standard	Auth. est. accuracy ± 4%
◇	Sweeny, W. O.	50-14 also 47-14	852-1572	Stellite 31 (AMS-5382, NRDC-71): 23.0-28.0% Cr; 9.0-12.0% Ni; 6.0-9.0% W; <2.0% Fe; 0.45-0.60% C; ρ = 538 lb_m/ft^3	Not given	Data obtained at G. E.



THERMAL CONDUCTIVITY -- COBALT + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Sweeny, W. O.	50-14 also 47-14	852-1572	Stellite 21 (AMS-5385, NRDC-10); 25-30% Cr: 4.5-6.5% Mo: 1.[illegible]-3.5% Ni; 2.0% max. Fe; 0.20-0.35% C; ρ = 518 lb_m/ft^3	Not given; probably comparative; rods	Data obtained at BMI
□	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	1528-2440	Stellite No. 21; before test: 60.49% Co; 26.69% Cr; 5.42% Mo; 2.38% Ni; 1.54% Fe; 0.258% C; after test: 62.27% Co; 26.74% Cr; 5.42% Mo; 2.42% Ni; 1.23% Fe; 0.264% C; ρ = 511 lb_m/ft^3	Single flat plate; boiling liquid calorimeter	Test history shows alloy to have been aged for a period of about 15 hr. in the temp. range 1400-2000°F before lower temp. data were taken
△	Sweeny, W. O.	50-14 also 47-14	852-1572	Stellite 23 (AMS-5375, NRDC-61); 23.0-29.0% Cr; 4.0-7.0% W; <2.0% Fe; <1.50% Ni; 0.35-0.50% C; ρ = 5[illegible]3 lb_m/ft^3	Not given	Data obtained at G.E.
◇	Ibid.	50-14 also 47-14	852-1572	Stellite 31 (AMS-5382, NRDC-71); 23.0-28.0% Cr; 9.0-12.0% Ni; 6.0-9.0% W; <2.0% Fe; 0.45-0.60% C; ρ = 538 lb_m/ft^3	Same as above	Same as above
▽	Evans Jr., J. E.	51-16	675-1490	X-40; 25.5% Cr; 10.5% Ni; 7.5% W; 2.0% Fe; 0.53% C	Comparative; rods (Pb standard)	Auth. est. accuracy ± 4%

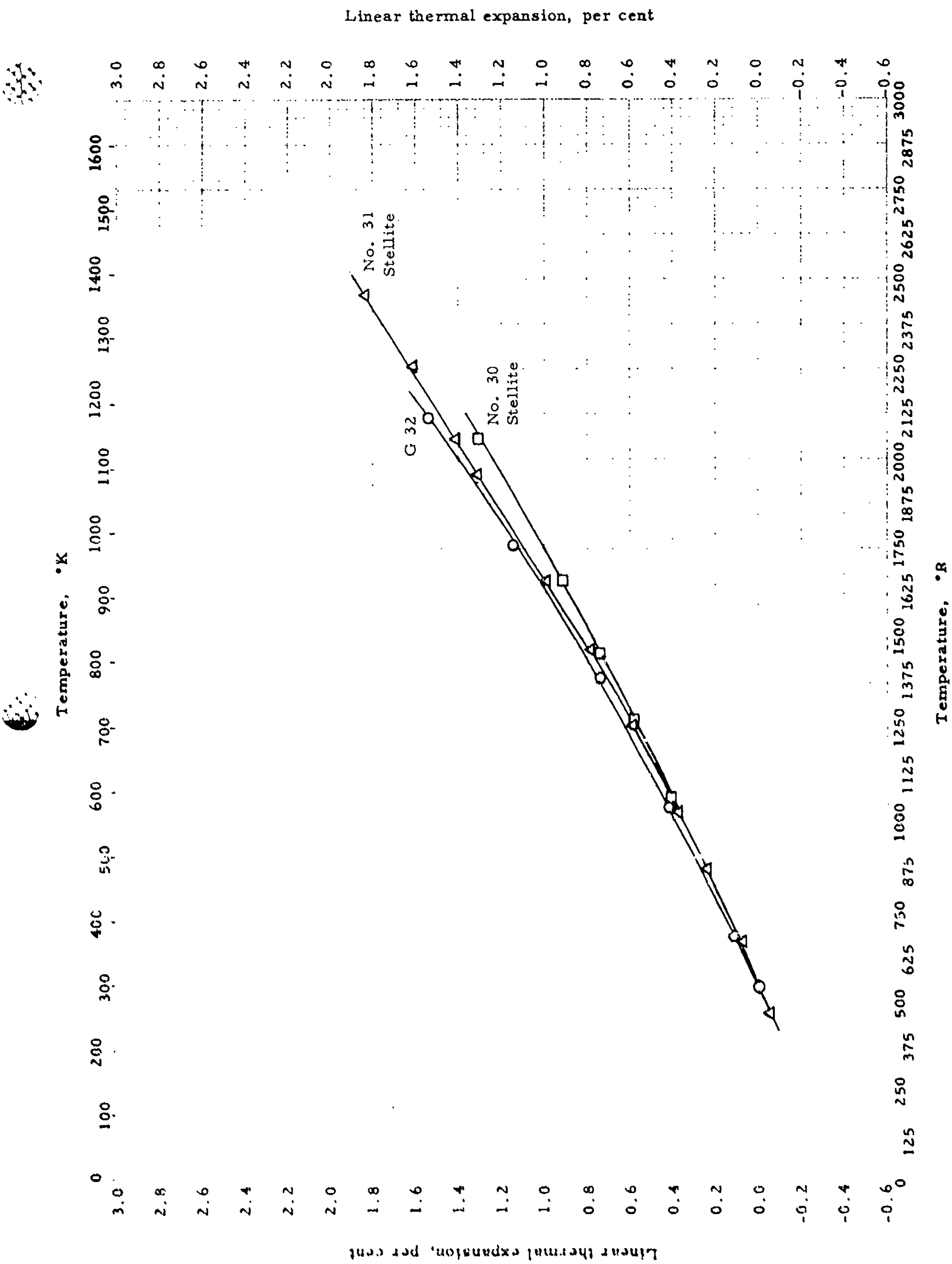


LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + MOLYBDENUM + X

LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Apblett, W. R. and Pellini, W. S.	51-5	528-2860	Vitallium: 62.2% Co; 27.4% Cr; 5.5% Mo; 2.8% Ni; 0.7% Fe; 0.66% Mn; 0.53% Si; 0.22% C	Strain gages on channel shaped clip fastened to pins welded on sample	Heating rate of 200°F/sec.
□	Fieldhouse, I. B., Hedge, J. C. et al.	58-4	540-2744	Stellite 21: 60.49% Co; 26.69% Cr; 5.42% Mo; 2.38% Ni; 1.54% Fe; 0.258% C. $\rho = 511.2\ lb_m/ft^3$	Telemicroscopes sighting on sample	After testing, material analyzed as 62.27% Co; 26.74% Cr; 5.42% Mo; 2.42% Ni; 1.23% Fe; 0.264% C.
△	Sweeney, W. O.	50-14 also 47-14	460-2410	Stellite 21 (NDRC No. NR-10; AMS No. 5385): 25.0-30.0% Cr; 4.5-6.5% Mo; 1.5-3.5% Ni; 2.0 max. Fe; 0.20-0.35% C. $\rho = 518\ lb_m/ft^3$	Not given	Measured at Batelle Mem. Inst. for NDRC.

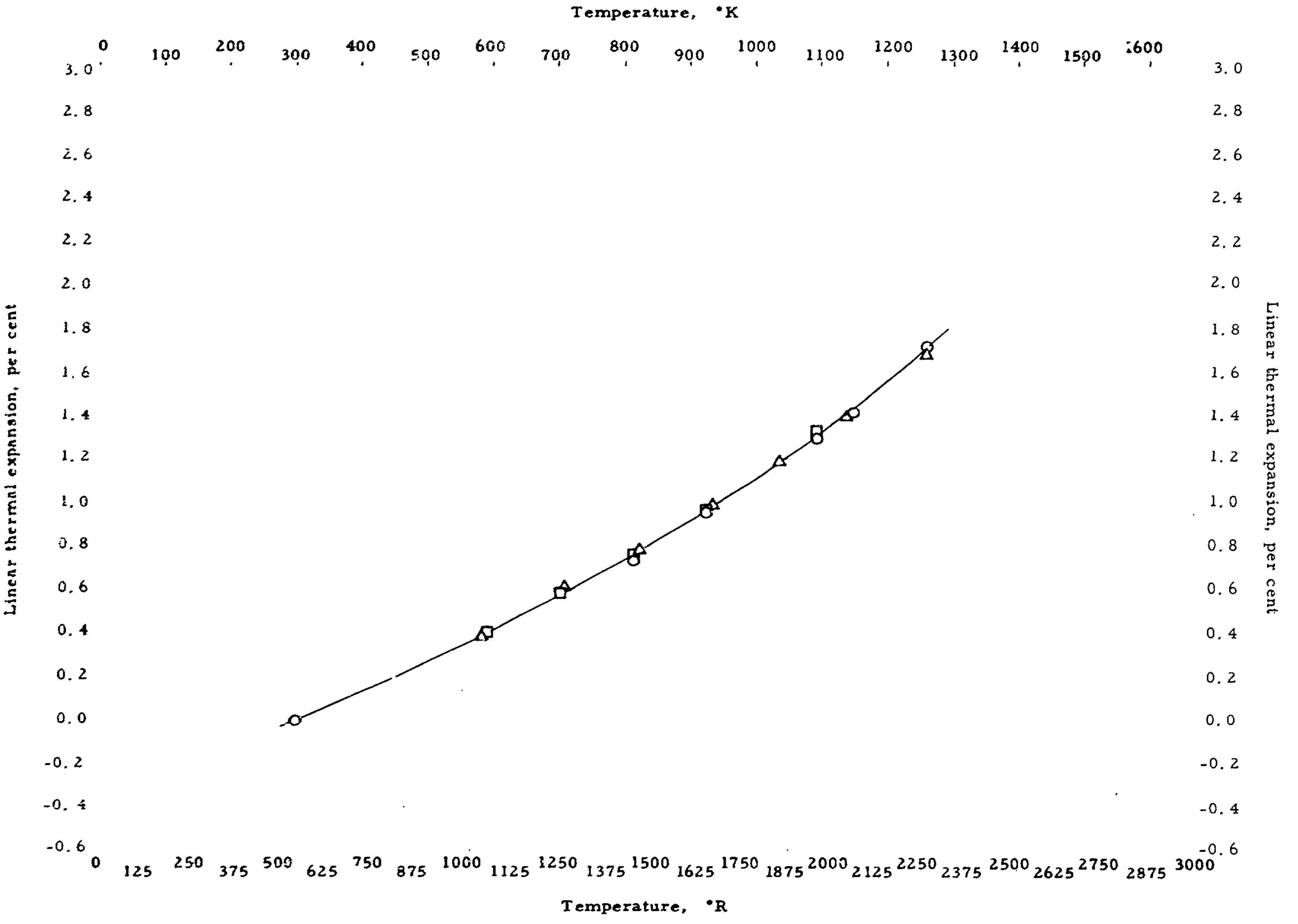


LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + NICKEL + X

LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Oliver, D. A. and Harris, M. A.	52-25	528-2112	Jessop G32 Steel (Brit. desig.): 46.6% Co; 19.1% Cr; 10.5% Ni; 3.9% V; 2.2% Mo; 1.4% Nb; 0.77% Mn; 0.52% Si; 0.27% C; balance Fe	Not given	Data given as appendix to paper presented at symposium.
□	Sweeny, W.O.	50-14	1060-2060	Haynes Stellite Alloy No. 30. NR-12 AMS-5380. Nominal: 23.0% - 29.0% Cr; 13.0% - 17.0% Ni; 5.0% - 7.0% Mo, 2.0% Fe max; 0.35% - 0.50% C	Not given	Measured at Battelle for N.D.R.C.
△	Ibid.	50-14	460-2060	Haynes Stellite Alloy No. 31. NR-71 AMS-5382. Nominal: 23.0% - 28.0% Cr; 9.0%-12.0% Ni; 6.0% - 9.0% W; 2.00% Fe max; 0.45% - 0.60% C	Not given	Measured by Union Carbide and Carbon Research Laboratories

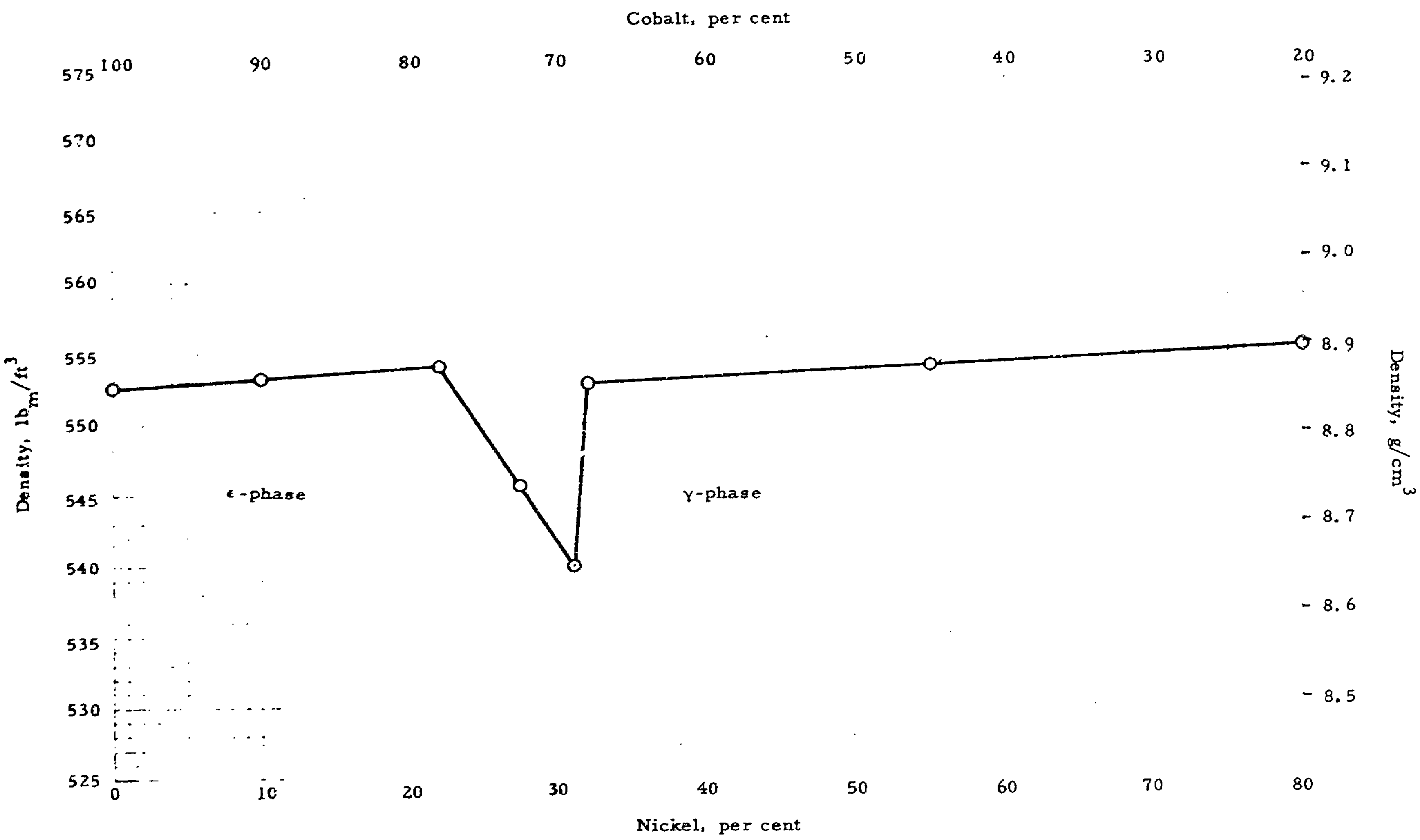


LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + TUNGSTEN + X

LINEAR THERMAL EXPANSION -- COBALT + CHROMIUM + TUNGSTEN + X

REFERENCE INFORMATION

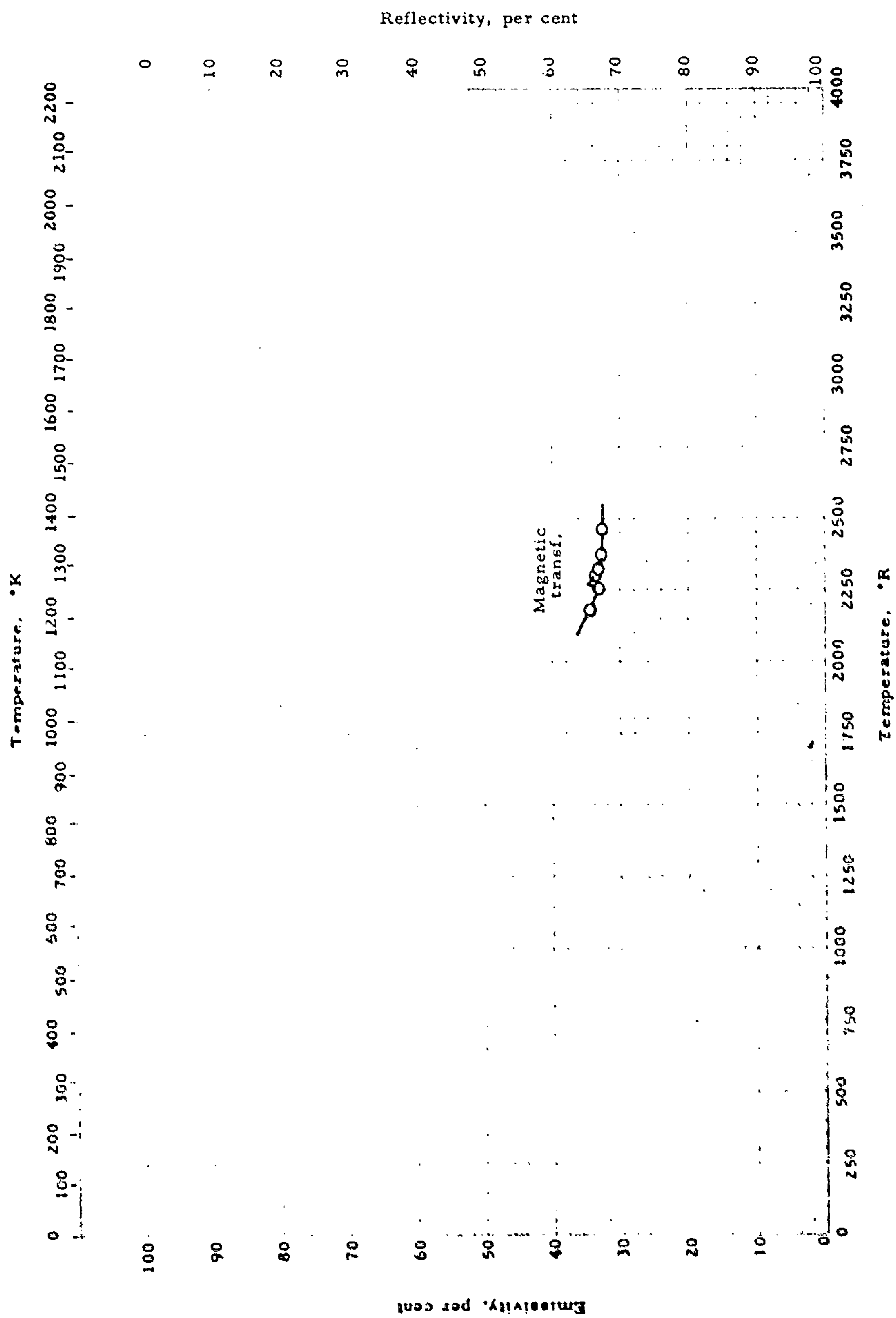
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Buswell, R. W. A., Pitkin, W. R. and Jenkins, I.	52-28	528-2260	Nominal: 64% Co; 30% Cr; 6% W ρ = 526 lb_m/ft^3	Not given	Powders mixed 15 hr, pressed at 35 $tons/in^2$, sintered in dry H_2 for 8 hr. at 1325°C
□	Sweeney, W. O.	50-14 also 47-14	1060-1960	Stellite 23 (NDRC61; AMS - 5375) Nominal: 23 - 29% Cr; 4.0 - 7.0% W; 2.0% Fe max; 1.50% Ni max; 0.35-0.50% C. ρ = 533 lb_m/ft^3	Not given	Measurements made at Battelle Memorial Institute for N.D.R.C.
△	Ibid.	50-14 also 47-14	1060-2260	Haynes Alloy No. 25 (L605) Nominal: 19.0 - 21.0% Cr; 14.0 - 16.0% W; 9.0 - 11.0% Ni; 1.0 - 2.0% Mn; <2.0% Fe; <1.0% Si; <0.15% C. ρ = 571 lb_m/ft^3	Not given	



DENSITY -- COBALT + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Yamamoto, M.	50-35	Room	0 - 60% Ni; made from 99.92% pure Ni and 99.87% pure Co	Weight in air and in distilled water	Melted in alumina tube. Electrolytic Ni contained 0.037% Fe; 0.030% Co; 0.023% As; 0.020% Cu; 0.01% C; 0.009% P; 0.001% ea. Si, Mn; no S. Electrolytic Co contained 0.117% Fe; 0.06% C, 0.02% ea. As, Cu; 0.013% P, 0.001% ea. Si, Mn; no Ni, S. Forged, annealed, rolled, annealed, machined to size, annealed 2 hrs at 1100° C

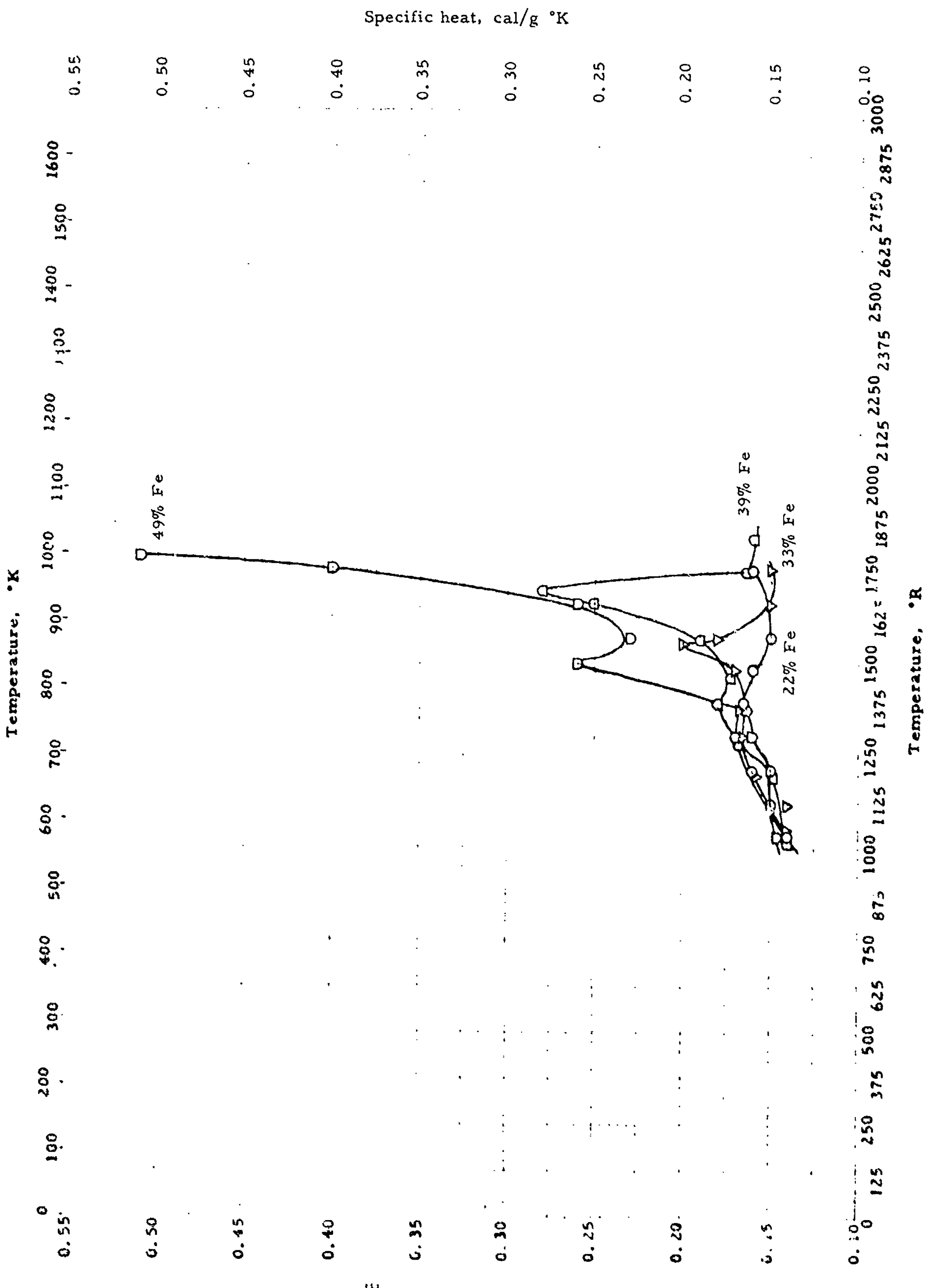


EMISSIVITY -- COBALT + NICKEL

EMISSIVITY -- COBALT + NICKEL

REFERENCE INFORMATION

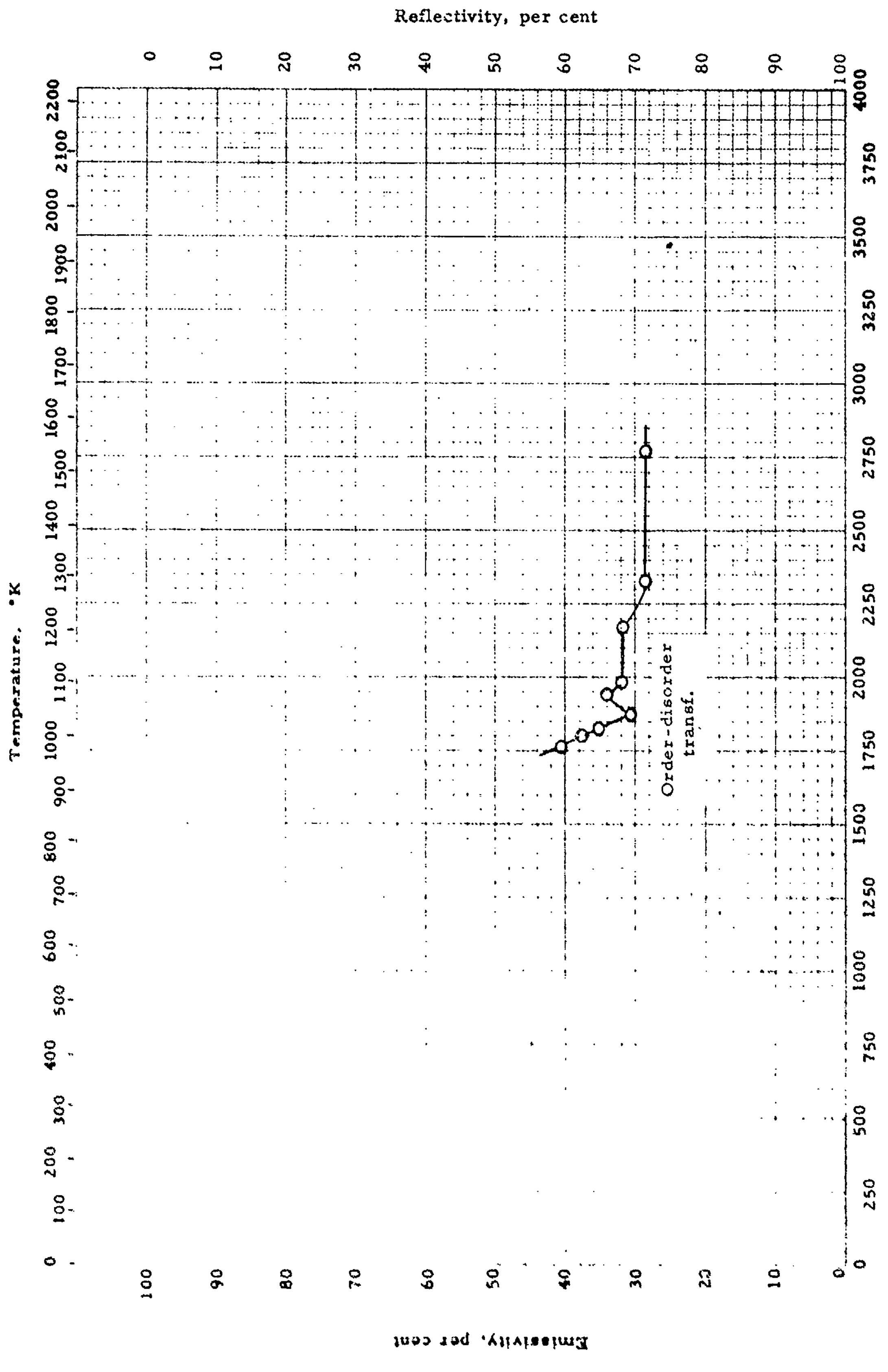
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Wahlin, H.B. and Knop Jr., H.W.	48-13 also 48-12	2178-2466	65% Co; 35% Ni	Spectral normal emissivity at 0.665μ : comparative: surface brightness compared with that of a black body hole through glass window; optical pyrometer	



SPECIFIC HEAT -- COBALT + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Masumoto, H., Saito, H. and Shinozaki, M.	54-118	1032-1752	78% Co; 22% Fe	Comparative; rate of cooling of sample compared with that of standard	Electrolytic Co and Fe; melted in H_2, annealed 2 hr. 2292°R, cooled to 1248°R at 54°R per hr., held 10 days at 1248°R, cooled to room temp. at 54°R per hr.
▽	Ibid.	54-118	1032-1752	67.3% Co; 32.7% Fe	Same as above	Same as above
◻	Ibid.	54-118	1032-1752	61% Co; 39% Fe	Same as above	Same as above
◻	Ibid.	54-118	1032-1842	51.4% Co; 48.6% Fe	Same as above	Same as above. Auth. also reports specific heat data for 24, 27, 30, 34 and 44% Fe

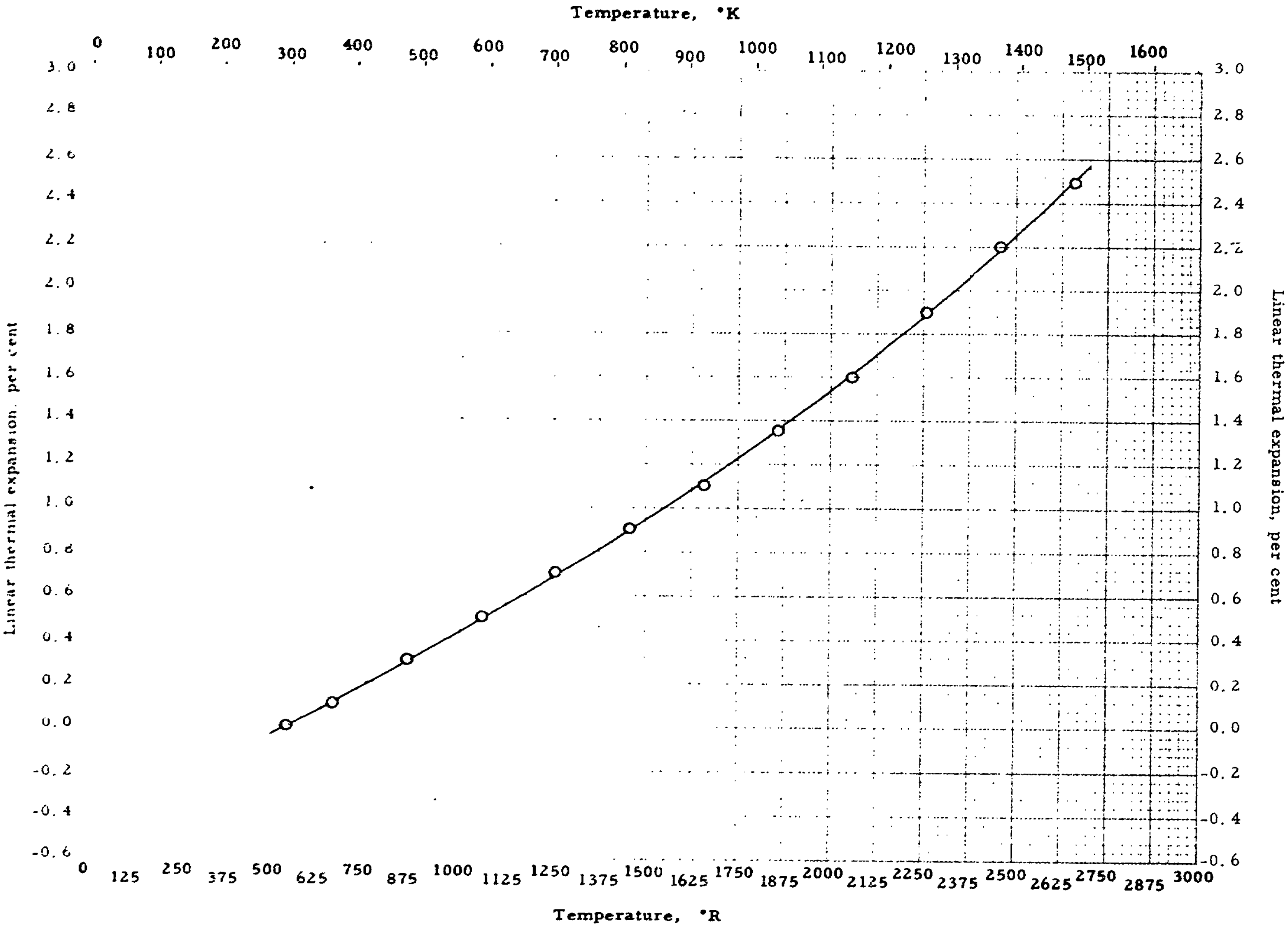


EMISSIVITY -- COBALT + IRON

EMISSIVITY -- COBALT + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Knop Jr., H. W.	48-6	1764-2772	60% Co; 40% Fe;	Spectral normal emissivity at 0.667μ : comparative: surface brightness compared with that of a black body hole; optical pyrometer	Prepared electrolytically

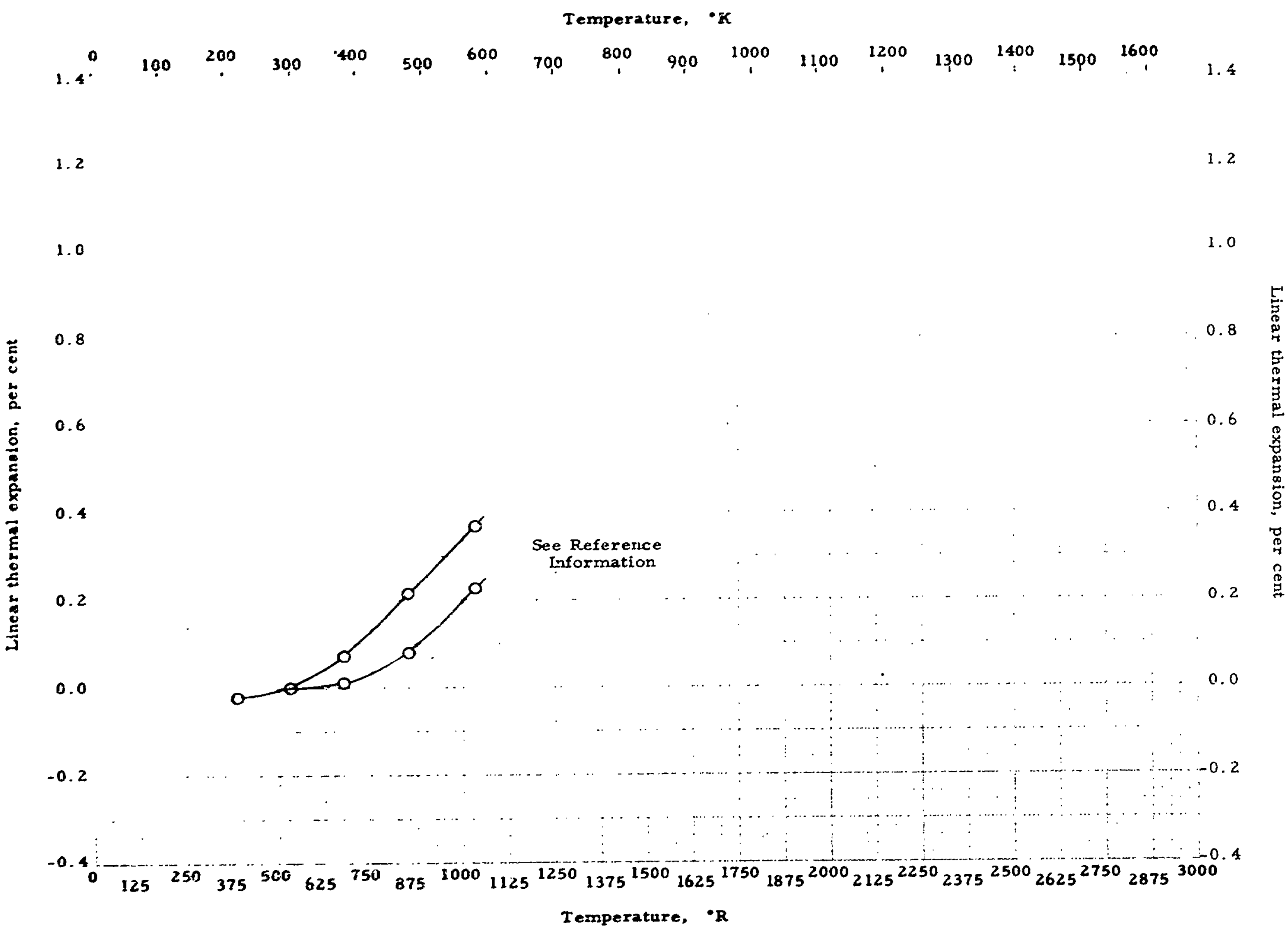


LINEAR THERMAL EXPANSION -- COBALT + IRON + CHROMIUM + NICKEL + X

LINEAR THERMAL EXPANSION -- COBALT + IRON + CHROMIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Apblett, W. R. and Pellini, W. S.	51-5	528-2660	30.2% Co; 23.25% Fe; 21.0% Cr; 20.5% Ni; 2.43% Mo; 1.67% Mn; 0.17% C; 0.119% N_2	Strain gages on channel-shaped clips fastened to pins welded on sample	Heating rate: 200°F/sec.

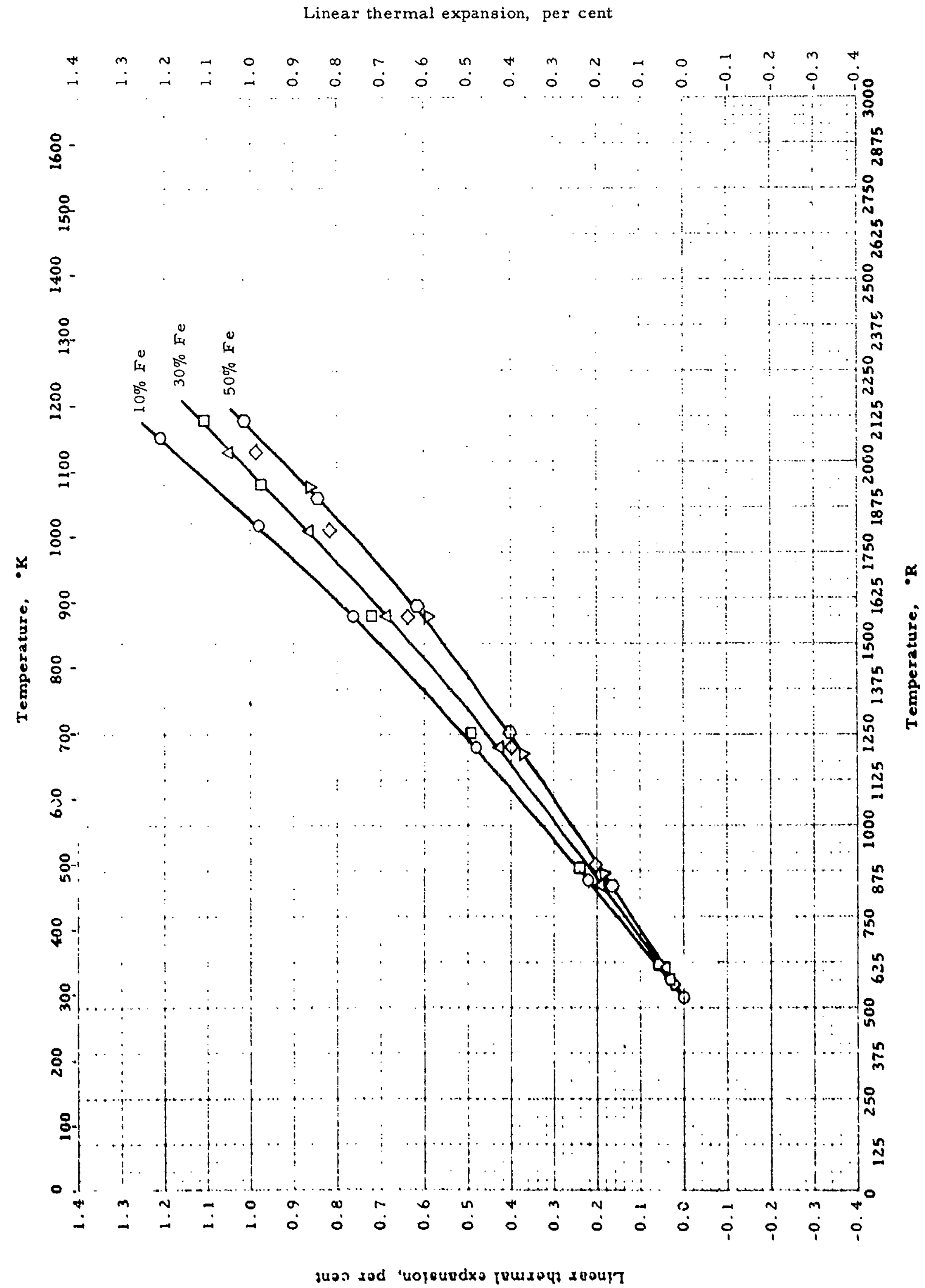


LINEAR THERMAL EXPANSION -- COBALT + IRON + CHROMIUM + X

LINEAR THERMAL EXPANSION -- COBALT + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Kirby, R. K.	55-41	384-1032	19 stabilized samples: between 53.1 - 54.32% Co; 36.22 - 37.2% Fe; 8.56 - 9.87% Cr; <0.33% Si; <0.11% C; <0.10% Mn; α and/or γ phase	Optical comparator	H_2 annealed 1 hr. at 1000°C, furnace cooled over 20 hr. Expansion extremes are plotted; auth. gives detailed data for materials within given composition range

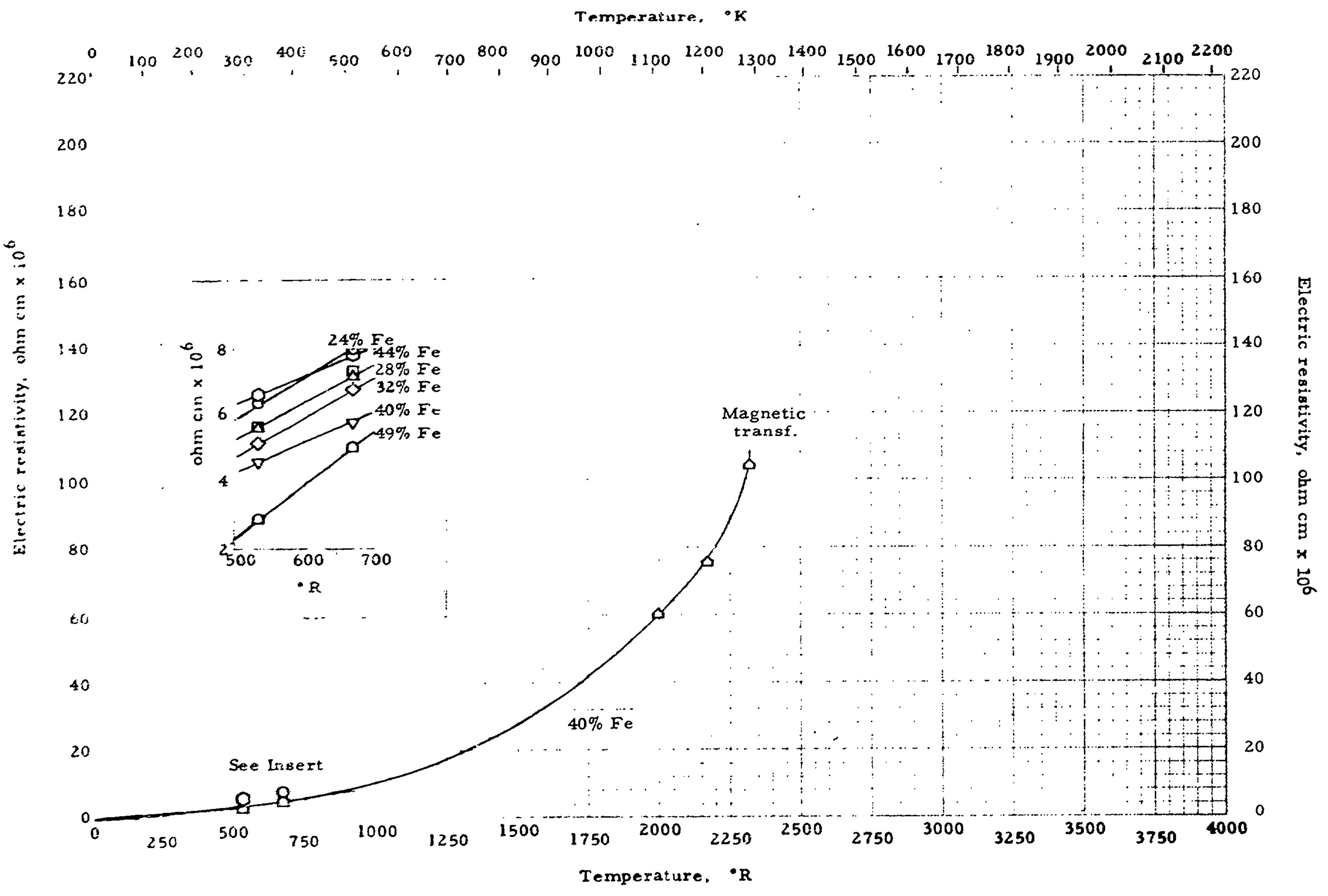


LINEAR THERMAL EXPANSION -- COBALT + IRON + X

LINEAR THERMAL EXPANSION -- COBALT + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Fine, M. E. and Ellis, W. C.	48-21 also 48-22	672-2067	89.6% Co by diff.; 9.6% Fe; 0.63% Mn; 0.03% Si	Silica tube dilatometer tested at 200° C/hr. rise	Induction melted in vacuum from Armco iron and cobalt rondelles, swaged, annealed 1 hr. at 900° C in H_2, cooled slowly
□	Ibid.	48-21	672-2112	79.4% Co; 20.2% Fe; 0.48% Mn; 0.01% Si	Same as above	Same as above
△	Ibid.	48-21	672-2022	69.6% Co; 29.8% Fe; 0.39% Mn; < 0.01% Si	Same as above	Same as above
◇	Ibid.	48-21	672-2022	59.8% Co; 39.4% Fe: 0.58% Mn; <0.01% Si	Same as above	Same as above
▽	Ibid.	48-21	672-1932	52.1% Co: 47.89% Fe by diff.; 0.01% Ni	Same as above	Prepared from electrolytic Fe and Co. Same heat treatment as above
○	Ibid.	48-21	672-2112	50.1% Co; 49.[illegible]% Fe; 0.47% Mn; <0.01% Si	Same as above	Prepared from Armco iron and cobalt rondelles. Same heat treatment as above
⌂	Masumoto, H., Saito, H. and Kobaya, T.	52-121	510-582	60% Co; 40% Fe by diff.	Not described here, refers to others	Induction melted from electrolytic Fe and electrolytic Co, deoxidized with 0.1% Al, cast, forged, heated 1 hr. at 1000° C in vacuum, furnace cooled. Auth. gives mean coeff. of exp. 20-50°C for alloys containing 60 - 80% Co
△	Ibid.	52-121	510-582	55% Co; 40% Fe by diff.; 5% V	Same as above	Made from electrolytic Fe and Co and ferro-vanadium. Same heat treatment as above. Auth. gives mean coeff. of exp. 20-50°C for alloys containing 50 - 70% Co and 0 - 13% V
▢	Masumoto, H., Saito, H. and Sagai, Y.	55-123 54-120	510-582	42% Co, 35% Fe; 23% Ni	Same as above	
▽	Ibid.	55-123 54-120	510-582	38% Co; 31% Fe; 23% Ni; 8% Cr	Same as above	Auth. gives mean coeff. of exp. 20-50°C, for alloys containing 35-38% Co, 27-33% Fe, 23% Ni, and 5 - 15% Cr



ELECTRIC RESISTIVITY -- COBALT + IRON

ELECTRIC RESISTIVITY -- COBALT + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Viting, L. M.	57-68	537-672	76.10% Co; 23.90% Fe	Potential drop	Annealed up to 1500 hr. at 500° C
□	Ibid.	57-68	537-672	73.24% Co; 26.76% Fe	Same as above	Same as above
△	Ibid.	57-68	537-672	71.04% Co; 21.96% Fe	Same as above	Same as above
◇	Ibid.	57-68	537-672	68.18% Co; 31.82% Fe	Same as above	Same as above
▽	Ibid.	57-68	537-672	60.22% Co, 39.78% Fe	Same as above	Same as above
⌂	Knop Jr., H. W.	48-6	1998-2326	60% Co; 40% Fe	Potential drop	Alloy prepared electrolytically
○	Viting, L. M.	57-68	537-672	56.00% Co; 44.00% Fe	Potential drop	Annealed up to 1500 hr. at 500° C
◠	Ibid.	57-68	537-672	51.14% Co; 48.86% Fe	Same as above	Same as above

Symbol	Nominal Composition, %			Melting Point	
	Co	Pd	Cu	°R	°K
○	50	40	10	2567	1426
	40	30	30	2553	1418

MELTING POINT -- COBALT + PALLADIUM + COPPER

MELTING POINT -- COBALT + PALLADIUM + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., Kuprina, V. V. et al.	56-31	2553-2567	Ternary system: 40-50% Co; 30-40% Pd; 10-30% Cu	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	

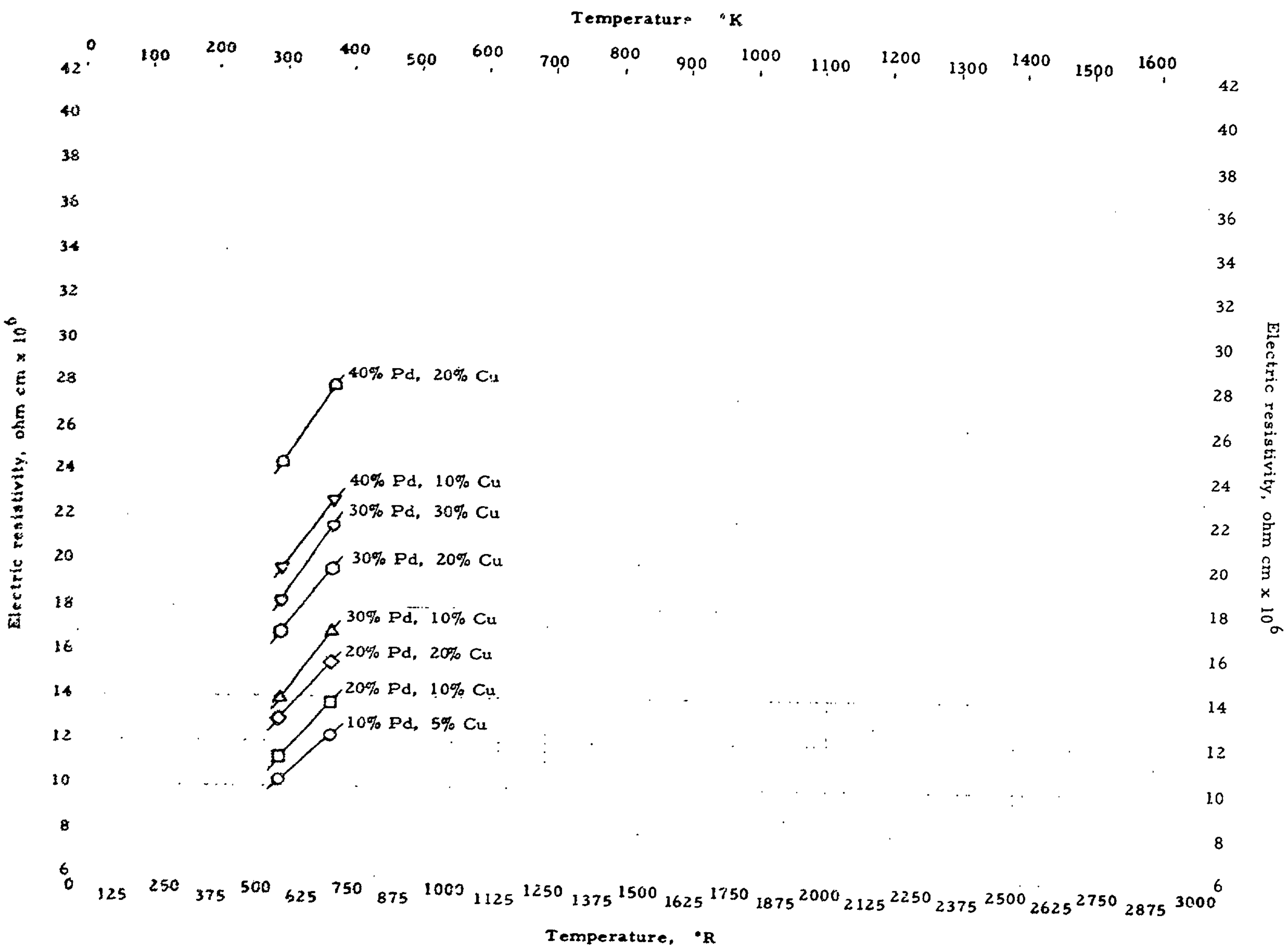
Symbol	Nominal Composition, %			Melting Point	
	Co	Pd	Au	°R	°K
O	88.0	10.0	2.0	3015	1675
	81.8	10.0	8.2	2450	1361
	74.8	20.0	5.2	2796	1553
	69.6	20.1	10.3	2585	1436
	64.6	30.2	5.2	2817	1565
	60.0	30.0	10.0	2763	1535
	54.6	40.1	5.3	2756	1531
	50.0	30.0	20.0	2639	1466
	49.7	40.1	10.2	2725	1514
	44.5	40.3	15.2	2688	1493
	40.0	40.0	20.0	2634	1463
	40.0	30.0	30.0	2634	1463

MELTING POINT -- COBALT + PALLADIUM + GOLD

MELTING POINT -- COBALT + PALLADIUM + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Sokolovskaya, E. M., Budennaya, L. D., et al.	56-32	2450-3015	Ternary system: 40-88% Co; 10-40.3% Pd; 2-30% Au	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled

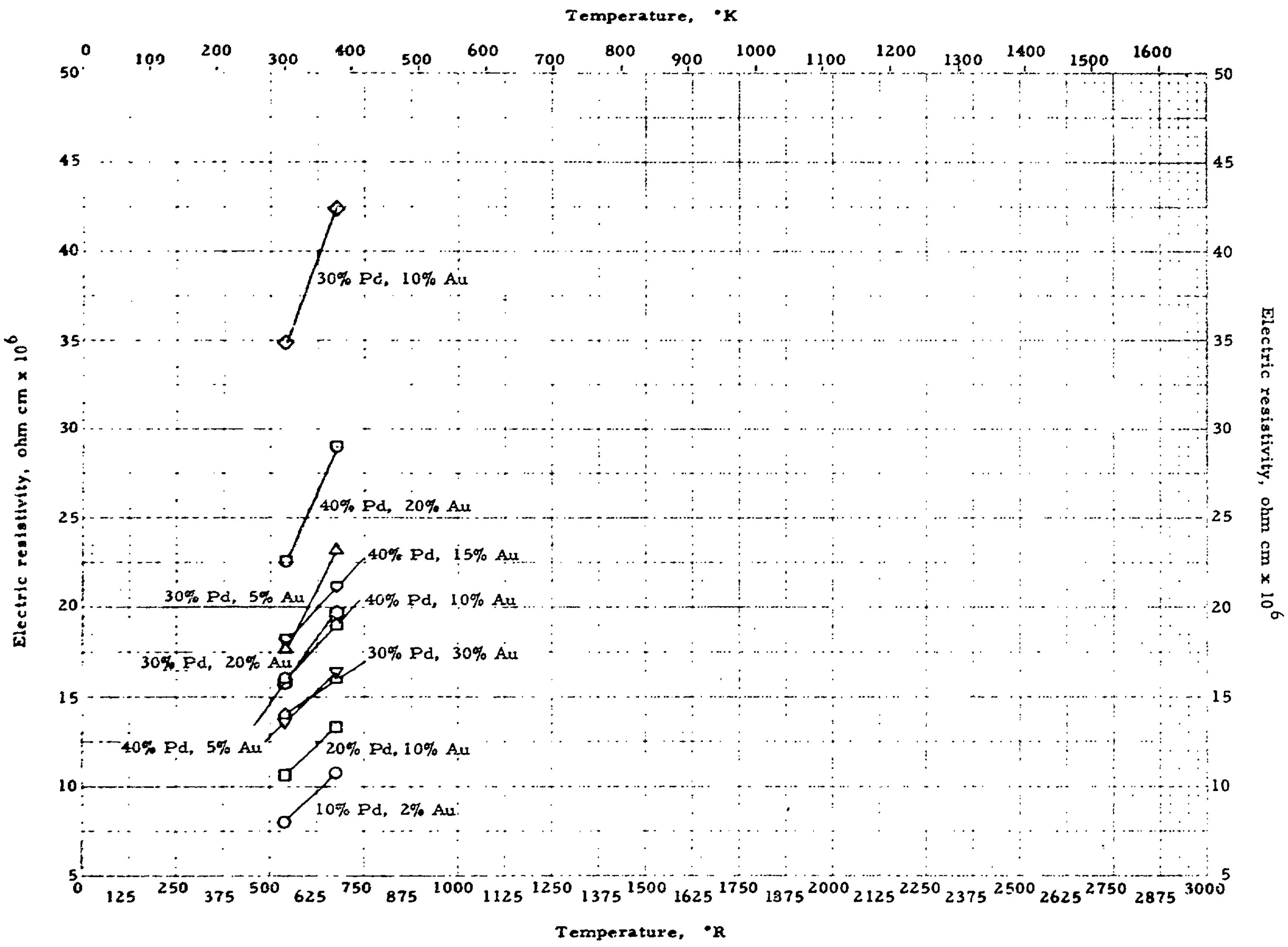


ELECTRIC RESISTIVITY -- COBALT + PALLADIUM + COPPER

ELECTRIC RESISTIVITY -- COBALT + PALLADIUM + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., Kaprina, V. V. et al.	56-31	537-672	85% Co; 10% Pd; 5% Cu	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	70% Co; 20% Pd; 10% Cu	Same as above	Same as above
△	Ibid.	56-31	537-672	60% Co; 30% Pd; 10% Cu	Same as above	Same as above
◇	Ibid.	56-31	537-672	60% Co; 20% Pd; 20% Cu	Same as above	Same as above
▽	Ibid.	56-31	537-672	50% Co; 40% Pd; 10% Cu	Same as above	Same as above
○	Ibid.	56-31	537-672	50% Co; 30% Pd; 20% Cu	Same as above	Same as above
□	Ibid.	56-31	537-672	40% Co; 40% Pd; 20% Cu	Same as above	Same as above
▽	Ibid.	56-31	537-672	40% Co; 30% Pd; 30% Cu	Same as above	Same as above



ELECTRIC RESISTIVITY -- COBALT + PALLADIUM + GOLD

ELECTRIC RESISTIVITY -- COBALT + PALLADIUM + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M. et al.	56-32	537-672	88% Co; 10% Pd; 2% Au	Potential drop	Annealed 100-150 hr. close to solidus temp. in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	69.6% Co; 20.1% Pd, 10.3% Au	Same as above	Same as above
△	Ibid.	56-32	537-672	64.6% Co; 30.2% Pd; 5.2% Au	Same as above	Same as above
◇	Ibid.	56-32	537-672	60% Co; 30% Pd; 10% Au	Same as above	Same as above
▽	Ibid.	56-32	537-672	54.6% Co; 40.1% Pd; 5.3% Au	Same as above	Same as above
⬡	Ibid.	56-32	537-672	50% Co; 30% Pd; 20% Au	Same as above	Same as above
⌂	Ibid.	56-32	537-672	49.7% Co; 40.1% Pd; 10.2% Au	Same as above	Same as above
▽	Ibid.	56-32	537-672	44.5% Co; 40.3% Pd; 15.2% Au	Same as above	Same as above
▽	Ibid.	56-32	537-672	40% Co; 40% Pd; 20% Au	Same as above	Same as above
⌂	Ibid.	56-32	537-672	40% Co; 30% Pd; 30% Au	Same as above	Same as above

Symbol	Nominal Composition, %			Melting Point	
	Co	Cu	Pd	°R	°K
O	60	30	10	2500	1389
	50	40	10	2500	1389
	50	30	20	2513	1396
	40	40	20	2547	1415
	40	30	30	2553	1418

MELTING POINT -- COBALT + COPPER + PALLADIUM

MELTING POINT -- COBALT + COPPER + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Panteleimonov, L. A., Kuprina, V. V. et al.	56-31	2500-2547	Ternary system: 40-60% Co; 30-40% Cu; 10-30% Pd	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	

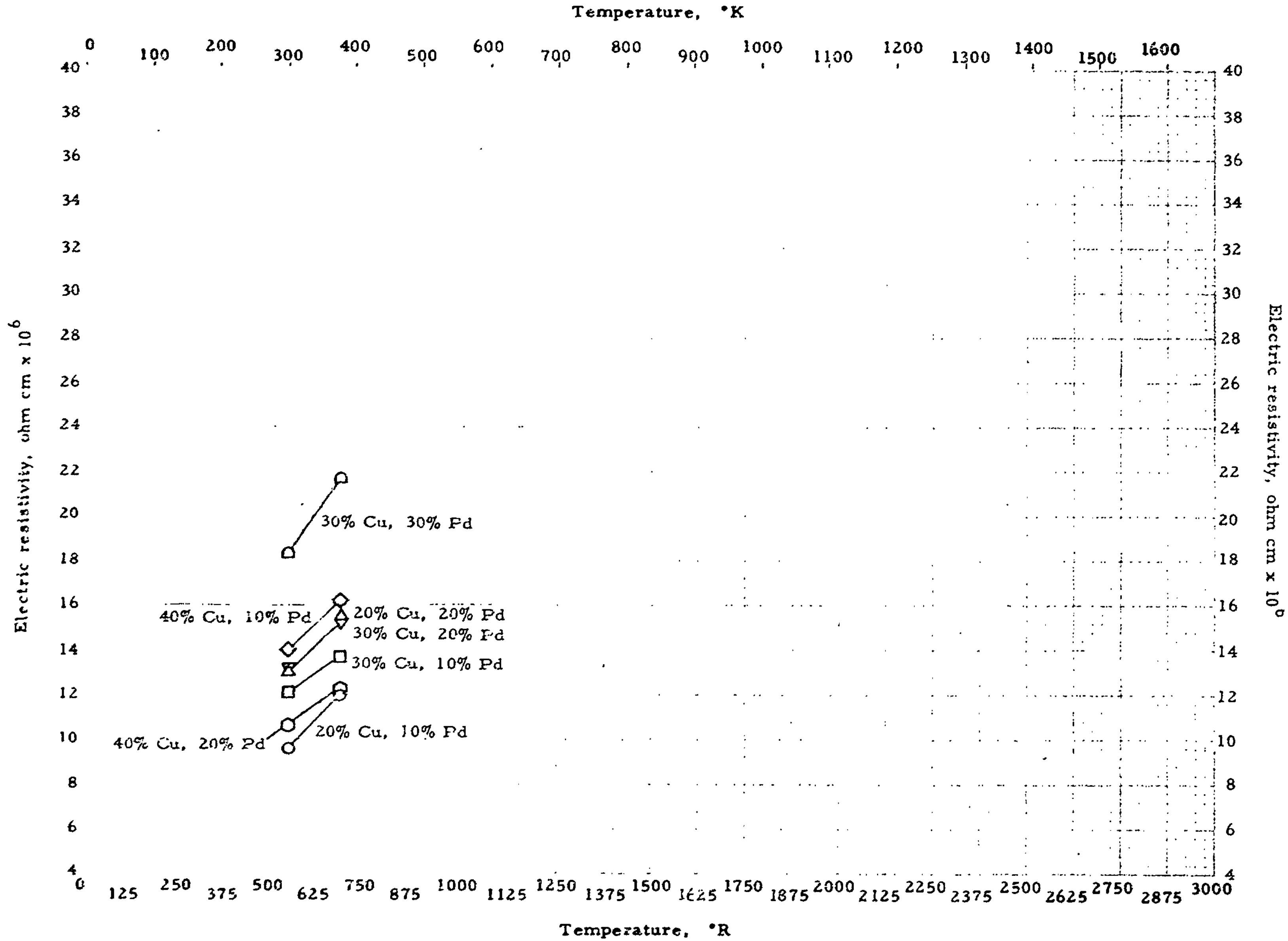
Symbol	Nominal Composition, %			Melting Point	
	Co	Au	Pd	°R	°K
O	70	20	10	2400	1333
	60	30	10	2382	1323
	59.5	20.3	20.2	2524	1402
	50	40	10	2373	1318
	50	30	20	2470	1372
	40	40	20	2634	1463
	40	30	30	2634	1463

MELTING POINT --COBALT + GOLD + PALLADIUM

MELTING POINT -- COBALT + GOLD + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Sokolovskaya, E. M., Budennaya, L. D. et al.	56-32	2400-2634	Ternary system, 40-70% Co; 20-40% Au; 10-30% Pd. Ingredients with <0.01% impurities	MP: break in time-temp. curve during cooling: Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled

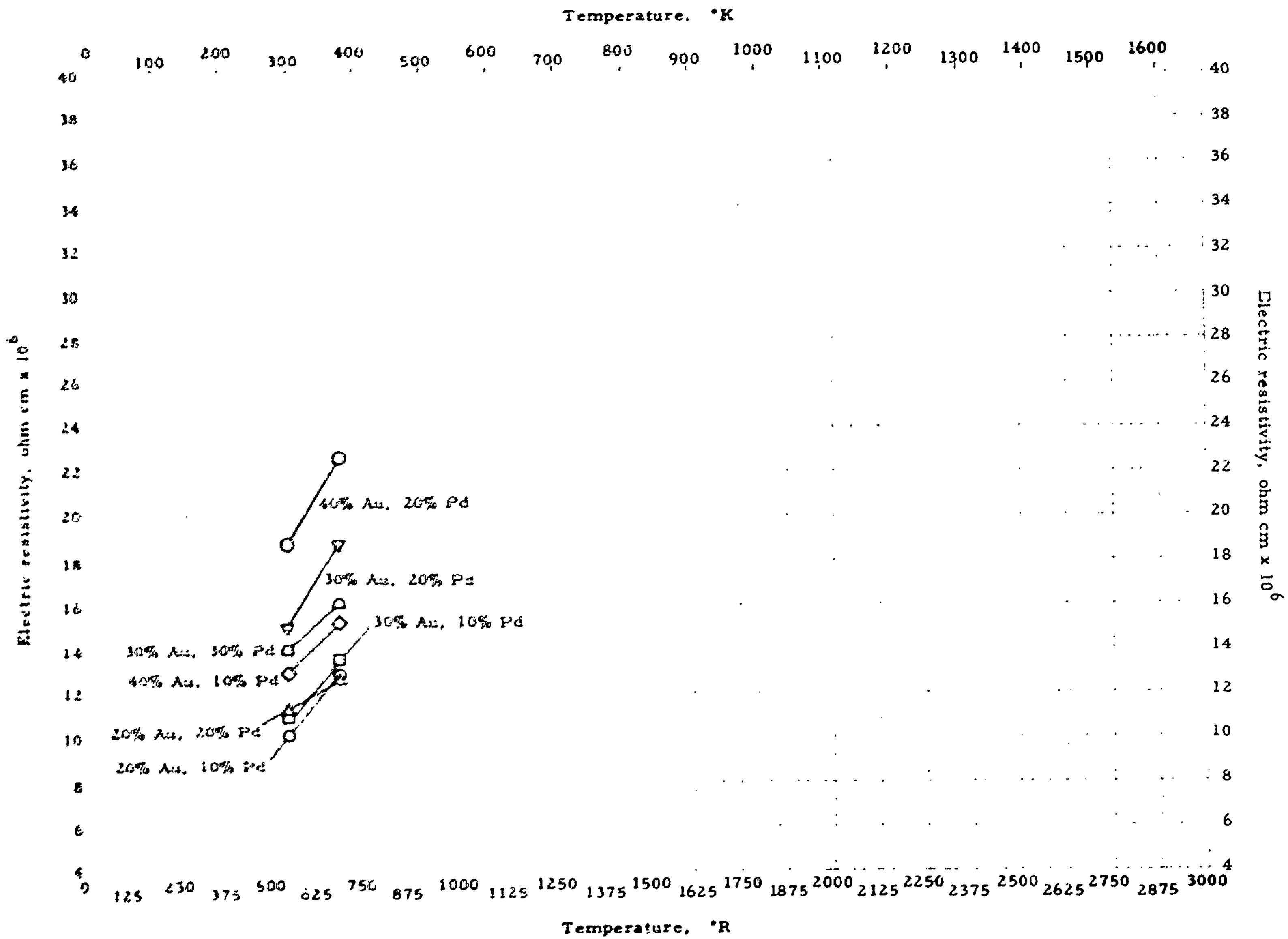


ELECTRIC RESISTIVITY -- COBALT + COPPER + PALLADIUM

ELECTRIC RESISTIVITY -- COBALT + COPPER + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., Kuprina, V. V. et al.	56-31	537-672	70% Co; 20% Cu; 10% Pd	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	60% Co; 30% Cu; 10% Pd	Same as above	Same as above
△	Ibid.	56-31	537-672	60% Co, 20% Cu; 20% Pd	Same as above	Same as above
◇	Ibid.	56-31	537-672	50% Co, 40% Cu; 10% Pd	Same as above	Same as above
▽	Ibid.	56-31	537-672	50% Co; 30% Cu; 20% Pd	Same as above	Same as above
◌	Ibid.	56-31	537-672	40% Co; 40% Cu; 20% Pd	Same as above	Same as above
◠	Ibid.	56-31	537-672	40% Co; 30% Cu, 30% Pd	Same as above	Same as above

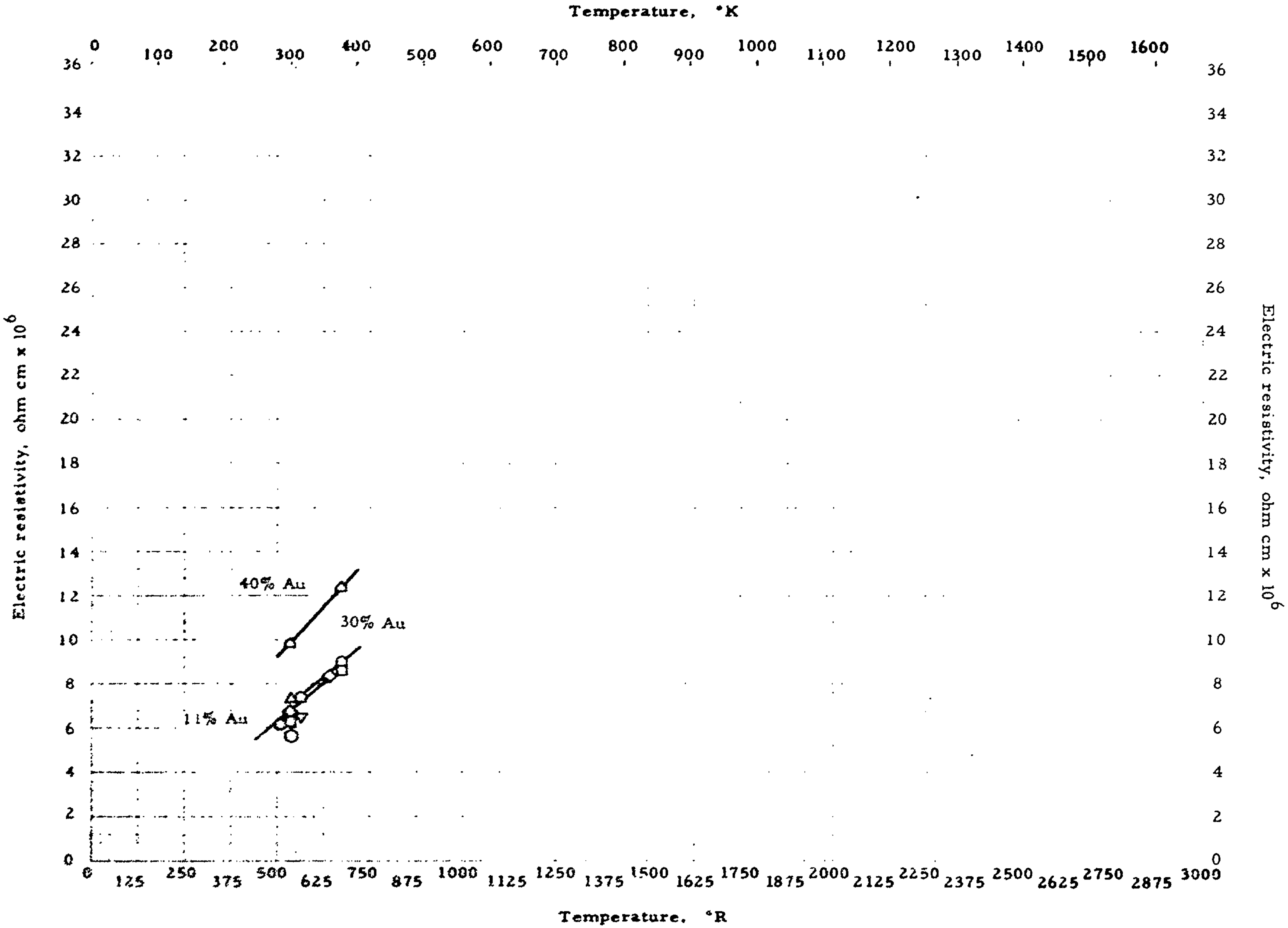


ELECTRIC RESISTIVITY -- COBALT + GOLD + PALLADIUM

ELECTRIC RESISTIVITY -- COBALT + GOLD + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskava, E.M. et al.	56-32	537-672	70% Co; 20% Au; 10% Pd	Potential drop	Annealed 100-150 hr. close to solidus temp. in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	60% Co; 30% Au; 10% Pd	Same as above	Same as above
△	Ibid.	56-32	537-672	54.5% Co; 20.3% Au; 20.2% Pd	Same as above	Same as above
◇	Ibid.	56-32	537-672	50% Co; 40% Au; 10% Pd	Same as above	Same as above
▽	Ibid.	56-32	537-672	50% Co; 30% Au; 20% Pd	Same as above	Same as above
⬡	Ibid.	56-32	537-672	40% Co; 40% Au; 20% Pd	Same as above	Same as above
⌂	Ibid.	56-32	537-672	40% Co; 30% Au; 30% Pd	Same as above	Same as above



ELECTRIC RESISTIVITY -- COBALT + GOLD

ELECTRIC RESISTIVITY -- COBALT + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M. and Maksimova, M. V.	56-125	537-672	100% Co	Potential drop	Melted from 99.99% pure Co and 99.99% pure Au.
□	Ibid.	56-125	537-672	98.0% Co; 2.0% Au	Same as above	Same as above
△	Ibid.	56-125	536-672	92.5% Co; 7.5% Au	Same as above	Same as above
◇	Ibid.	56-125	536-672	89.0% Co; 11.0% Au	Same as above	Same as above
▽	Ibid.	56-125	536-672	87.0% Co; 13.0% Au	Same as above	Same as above
○	Ibid.	56-125	536-672	85.0% Co; 15.0% Au	Same as above	Same as above
◘	Ibid.	56-125	536-672	70.0% Co; 30.0% Au	Same as above	Same as above
⌂	Ibid.	56-125	536-672	60.0% Co; 40.0% Au	Same as above	Same as above

Symbol	Nominal Composition, %		Melting Point	
	W	Nb	°R	°K
O	80	20	6278	3488
	70	30	5928	3293
	60	40	5802	3223
	50	50	5667	3148

MELTING POINT -- TUNGSTEN + NIOBIUM

MELTING POINT -- TUNGSTEN + NIOBIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mikheev, V.S. and Pevtsov, D.M.	58-8	5667-6279	Alloy system; 20 - 50% Nb; prepared from 99.95% pure W and 99.2% pure Nb	MP: collapse of black body hole; optical pyrometer	Powder pressed at 121,000 psi, sintered 24 hr. at 600-650°C; 100 hr. at 1150°C, formed into rods, sintered 100 hr. at 1200°C and 45 hr. at 1500°C

PROPERTIES OF TUNGSTEN + NICKEL + IRON

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 90% W	1070 lb_m/ft^3	17.2 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	1071	17.15
	□	1108	17.75
	◇	1135	18.18

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF TUNGSTEN + NICKEL + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Green, E.C., Jones, D.J. and Pitkin, W.R.	54-114	Room	90% W; 7% Ni; 3% Fe	ρ: not given	
□	Ibid.	54-114	Room	93% W; 4.9% Ni; 2.1% Fe	ρ: not given	
◇	Ibid.	54-114	Room	95% W; 3.5% Ni; 1.5% Fe	ρ: not given	

PROPERTIES OF TUNGSTEN + NICKEL + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 90% W	1060 lb_m/ft^3	17 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

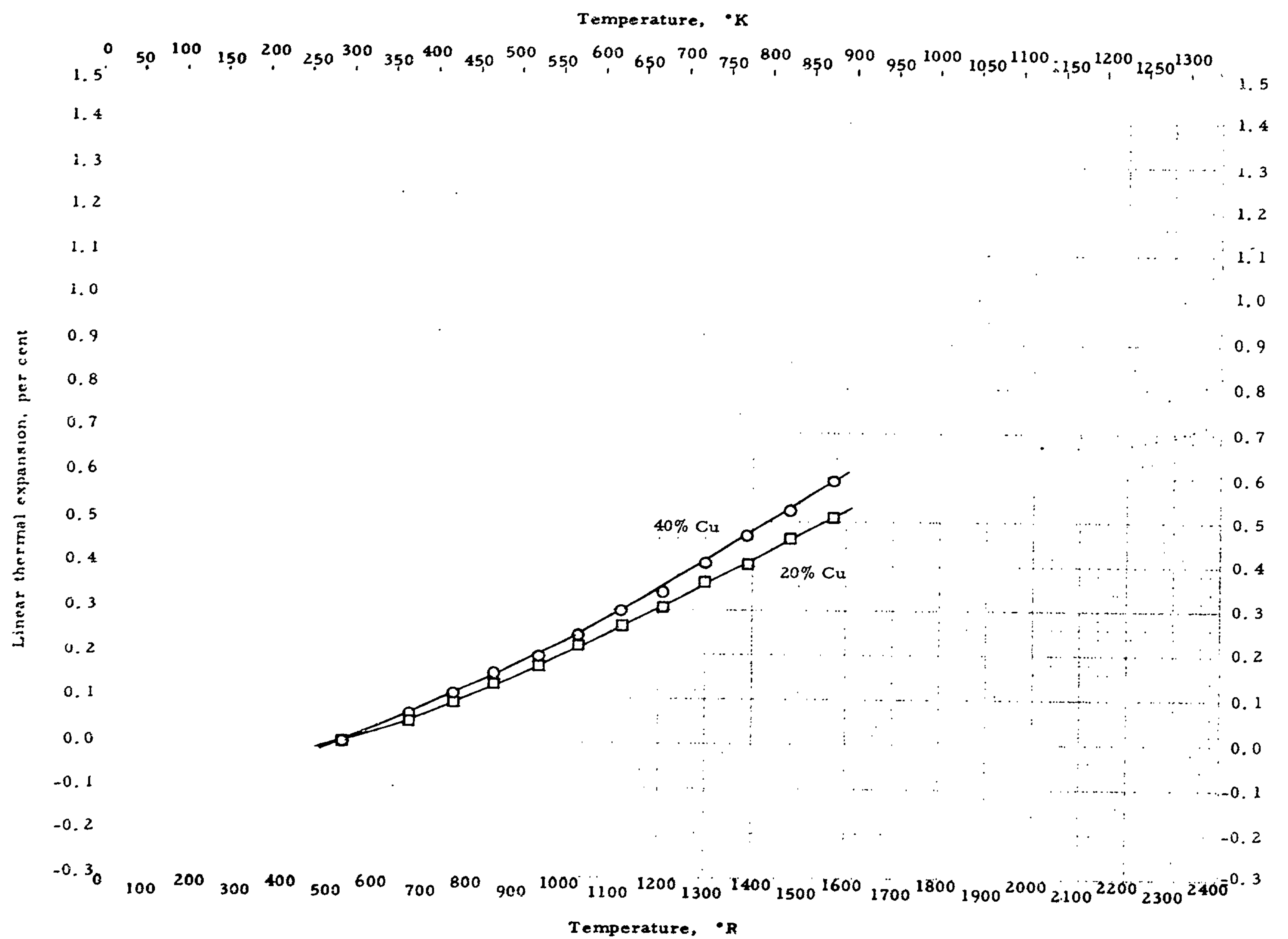
REPORTED VALUES

<u>Density:</u>		lb_m/ft^3	g/cm^3
	O	1045 ± 15	16.8 ± 0.3
<u>Melting Point:</u>		°R	°K
<u>Heat of Fusion:</u>		Btu/lb_m	cal/g
<u>Heat of Vaporization:</u>		Btu/lb_m	cal/g
<u>Heat of Sublimation:</u>		Btu/lb_m	cal/g

PROPERTIES OF TUNGSTEN + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Anon.	54-117	Room	GEC Heavy Alloy, (British desig.): nominal: 90% W; 7.5% Ni; 2.5% Cu	ρ: not given	

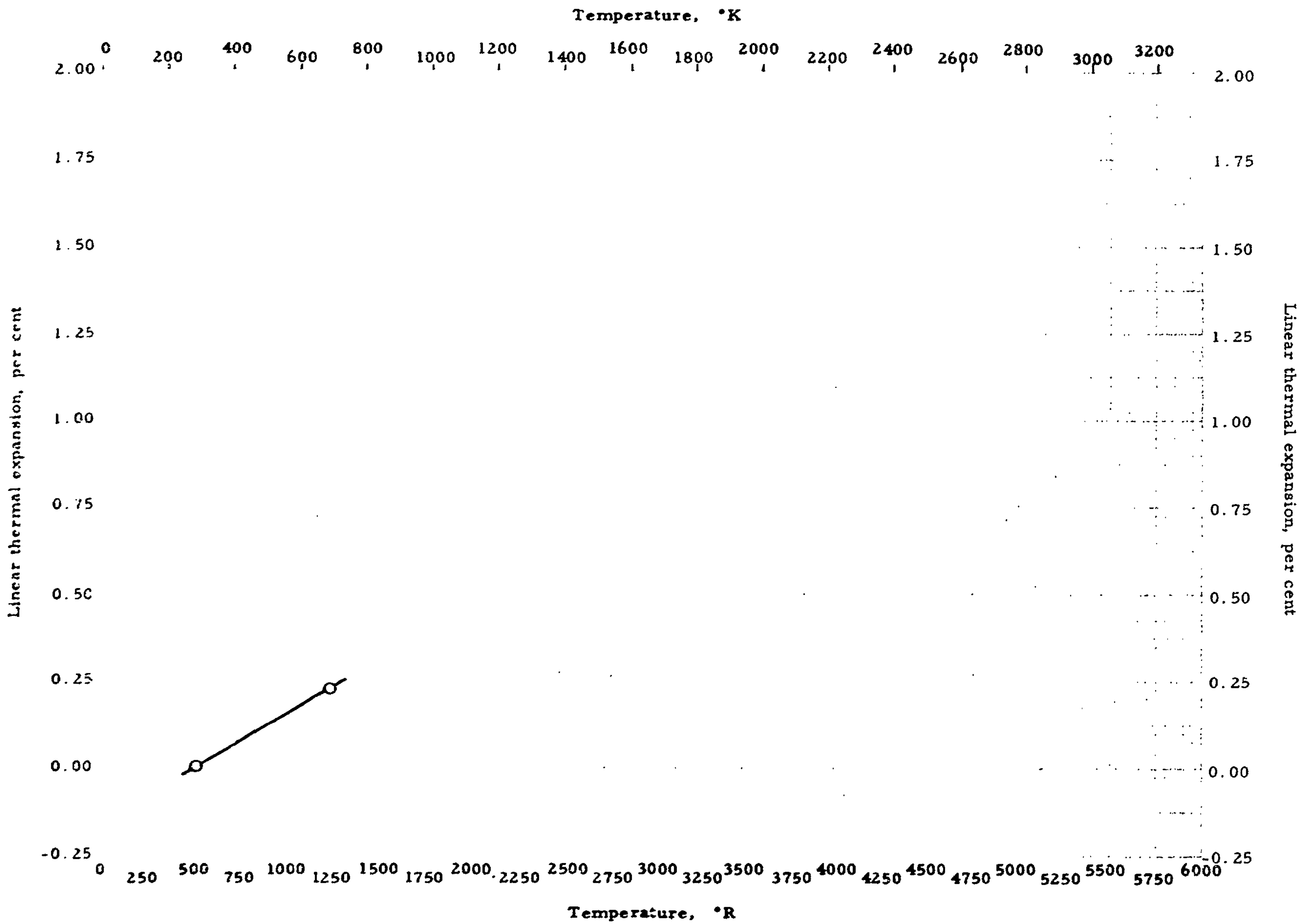


LINEAR THERMAL EXPANSION -- TUNGSTEN + COPPER MIXTURE

LINEAR THERMAL EXPANSION -- TUNGSTEN + COPPER MIXTURE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hensel, F. R. et al.	42-1	528-1570	60% W; 40% Cu; mixture, not alloy	Not given	
□	Ibid.	42-1	528-1570	80% W; 20% Cu; mixture, not alloy	Not given	



LINEAR THERMAL EXPANSION -- TUNGSTEN + NICKEL + X

LINEAR THERMAL EXPANSION -- TUNGSTEN + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Anon.	54-117	528-1248	Heavy Alloy (British desig.): nominal: 90% W; 7.5% Ni; 2.5% Cu	Not given	Made by British General Electric Co. Ltd. ρ = 1030-1060 lb_m/ft^3

PROPERTIES OF MOLYBDENUM + NICKEL + COPPER

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 54% Mo	570 lb_m/ft^3	9.1 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	566	9.06
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF MOLYBDENUM + NICKEL + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Brink, C. and Shoemaker, D.P.	55-119	Room	54% Mo; 31% Ni; 15% Cu	ρ: not given	

Symbol	Nominal Composition, %			Density	
	Mo	Nb	Ti	lb_m/ft^3	g/cm^3
O	80	10	10	528	8.45
	70	20	10	-	-
	60	30	10	476	7.62
	60	20	20	437	7.0
	50	40	10	459	7.35
	50	30	20	443	7.1
	40	40	20	425	6.80
	40	30	30	414	6.63

DENSITY -- MOLYBDENUM + NIOBIUM + TITANIUM

DENSITY - - MOLYBDENUM + NIOBIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kornilov, I.I. and Polyakova, R.S.	58-12	Room	Ternary alloy series; 40-80% Mo; 10-40% Nb; 10-30% Ti. Prepared from 99.9% pure Mo; 98.9% pure Nb; 99.5% pure Ti	ρ: weight in air and in water	Auth. note measured values 5-7% lower than theor. ρ from x-ray lattice dimensions. Pressed at 4 ton/cm^2 from powders, vacuum sintered 5 hr. ea. at 400°C, 600°C, 800°C, and 25 hr. at 1000°C; 12 hr. at 1700-1800°C

Symbol	Nominal Composition, % Mo	Ti	Nb	Density lb_m/ft^3	g/cm^3
O	80	10	10	528	8.45
	70	20	10	471	7.55
	60	30	10	417	6.68
	60	20	20	437	7.0
	50	40	10	395	6.32
	50	30	20	425	6.8
	40	40	20	384	6.15
	40	30	30	414	6.63

DENSITY -- MOLYBDENUM + TITANIUM + NIOBIUM

DENSITY--MOLYBDENUM + TITANIUM + NIOBIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kornilov, I.I. and Polyakova, R.S.	58-12	Room	Ternary alloy series: 40-80% Mo; 10-40% Ti; 10-30% Nb. Prepared from 99.9% pure Mo, 99.5% pure Ti; 98.9% pure Nb	ρ: weight in air and in water	Auth. note measured values 5-7% lower than theor. ρ from x-ray lattice dimensions. Pressed at 4 ton/cm^2 from powders. Vacuum sintered 5 hr. ea. at 400°C, 600°C, 800°C; 25 hr. at 1000°C, 12 hr. at 1700-1800°C

Symbol	Nominal Composition, %			Density	
	Nb	Mo	Ti	lb_m/ft^3	g/cm^3
O	80	10	10	453	7.25
	70	20	10	460	7.37
	60	30	10	471	7.55
	60	20	20	428	6.85
	50	40	10	459	7.35
	50	30	20	431	6.90
	40	40	20	425	6.80
	40	30	30	406	6.50

DENSITY -- NIOBIUM + MOLYBDENUM + TITANIUM

DENSITY -- NIOBIUM + MOLYBDENUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kornilov, I.I. and Polyakova, R.S.	58-12	Room	Ternary alloy series; 40-80% Nb. 10-40% Mo; 10-30% Ti. Prepared from 98.9% pure Nb; 1.0% Te; 0.05% Ti; 0.03% S. 0.02% C; 0.01% Fe: with 99.9% pure Mo; and 99.5% pure Ti; 0.1% Ni; 0.058% N_2; 0.042% Si; 0.04% C	ρ: weight in air and in water	Auth. note measured values 5-7% lower than theor. ρ from x-ray lattice dimensions. Pressed at 4 ton/cm^2 from powders. Vaccum baked 5 hr. ea. at 400°C, 600°C, 800°C and 25 hr. at 1000°C; 12 hr. at 1700-1800°C

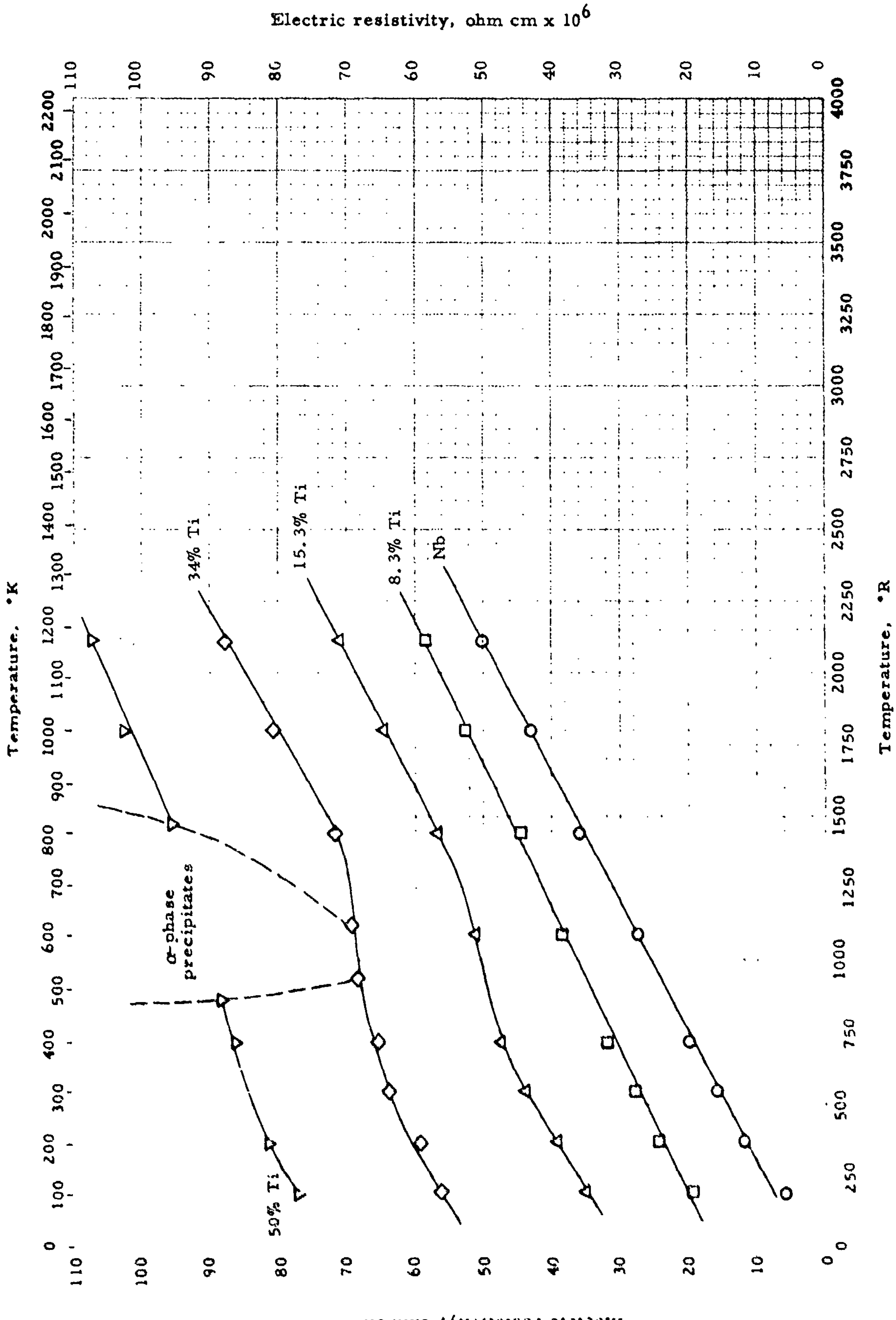
Symbol	Nominal Composition, %			Density	
	Nb	Ti	Mo	lb_m/ft^3	g/cm^3
O	80	10	10	453	7.25
	70	20	10	421	6.74
	60	30	10	382	6.12
	60	20	20	428	6.85
	50	40	10	320	5.12
	50	30	20	393	6.3
	40	40	20	384	6.15
	40	30	30	406	6.50

DENSITY -- NIOBIUM + TITANIUM + MOLYBDENUM

DENSITY -- NIOBIUM + TITANIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref	Range, °R	Material Composition	Test Method	Remarks
O	Kornilov, I.I. and Polvakova, R.S.	58-12	Room	Ternary alloy series, 40-80% Nb, 10-40% Ti, 10-30% Mo. Prepared from 99.9% pure Nb; 99.9% pure Mo; 99.5% pure Ti	ρ: weight in air and in water	Auth. note measured values 5-7% lower than theor. ρ from x-ray lattice dimensions. Pressed at 4 ton/cm^2 from powders, vacuum sintered 5 hr. ea. at 400°C, 600°C, 800°C and 25 hr. at 1000°C; 12 hr. at 1700-1800°C



ELECTRIC RESISTIVITY -- NIOBIUM + TITANIUM

ELECTRIC RESISTIVITY -- NIOBIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S. L. and McQuillan, A. D.	54-25	180-2112	100% Nb; β-phase; spectroscopically pure	Double bridge	Cast, rolled in sheet, remelted, hot forged, surface layer removed, cold swaged, homogenized 70 hr. at 1050°C in vacuum, quenched to retain β phase
□	Ibid.	54-25	180-2112	91.7% Nb; 8.3% Ti; β-phase; prepared from spectroscopically pure Nb and iodide Ti (0.2 atomic% Zr)	Same as above	Same as above
△	Ibid.	54-25	180-2112	84.7% Nb; 15.3% Ti; β-phase; raw materials same as above	Same as above	Same as above
◇	Ibid.	54-25	180-2112	66% Nb; 34% Ti; β-phase; raw materials same as above	Same as above	Same as above
▽	Ibid.	54-25	180-2112	50% Nb; 50% Ti; β-phase; raw materials same as above	Same as above	Same as above

PROPERTIES OF CHROMIUM + NICKEL + MOLYBDENUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point	2223°R	1568°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

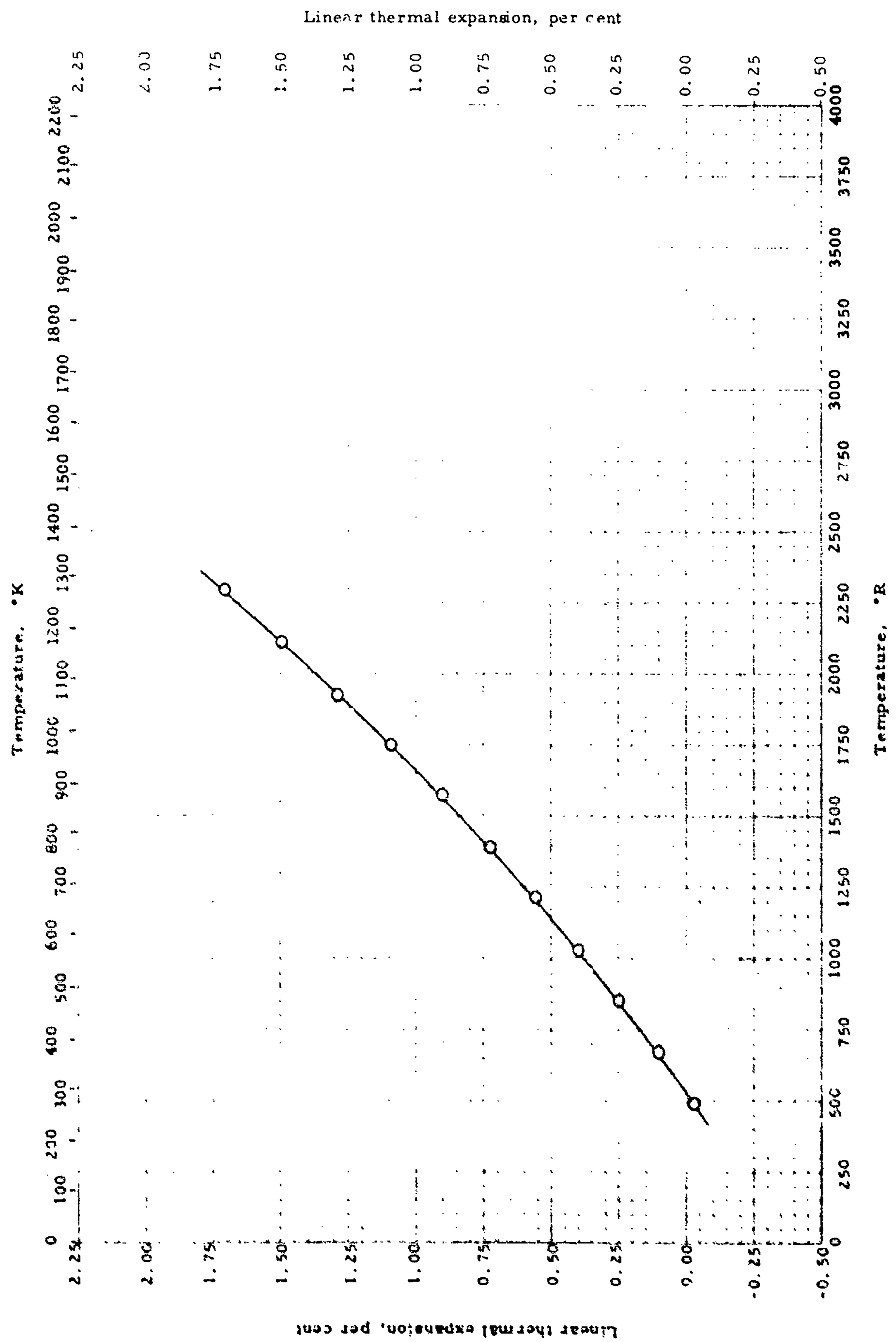
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	2223	1568
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF CHROMIUM + NICKEL + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Binder, I. and Moskowitz, D.	55-76	2823	Nominal: 48% Cr; 40% Ni; 12% Mo	MP: visual observation of powder in graphite crucible; optical pyrometer	Auth. est. accuracy ± 25°C



LINEAR THERMAL EXPANSION -- CHROMIUM + NICKEL

LINEAR THERMAL EXPANSION -- CHROMIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Esser, H. and Eusterbrock, H.	41-17	492-2292	Chronin - approx. analysis: 90% Cr; 10% Ni, traces of Fe	Interferometer dilatometer (compared to gold standard)	

PROPERTIES OF CHROMIUM + MOLYBDENUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 60% Cr	490 lb_m/ft^3	7.9 g/cm^3
Melting Point		
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

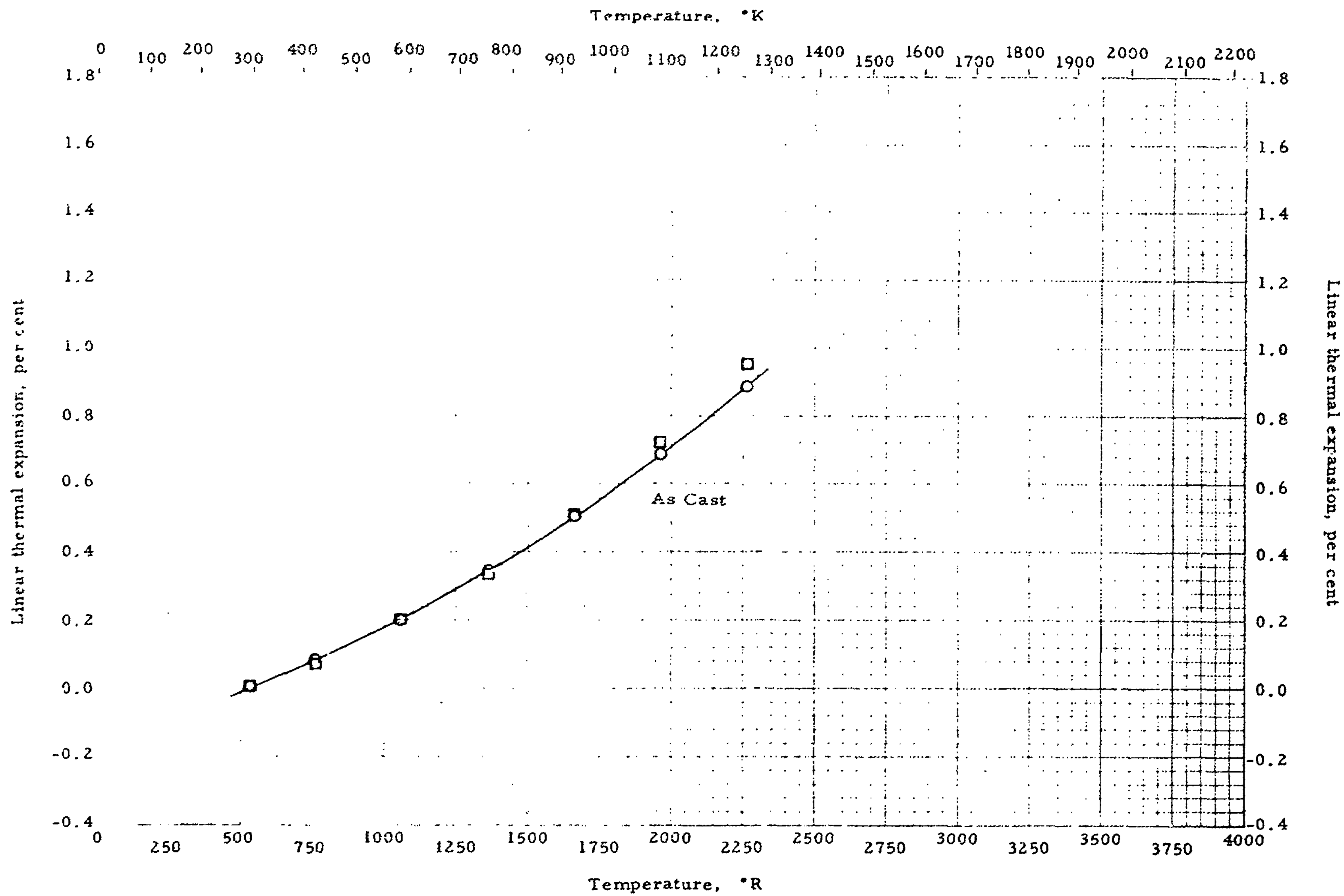
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	491	7.87
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF CHROMIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Parke, R.M. and Bens, F.P.	46-3	Room	60% Cr ; 25% Mo; 15% Fe	ρ: not given	As cast

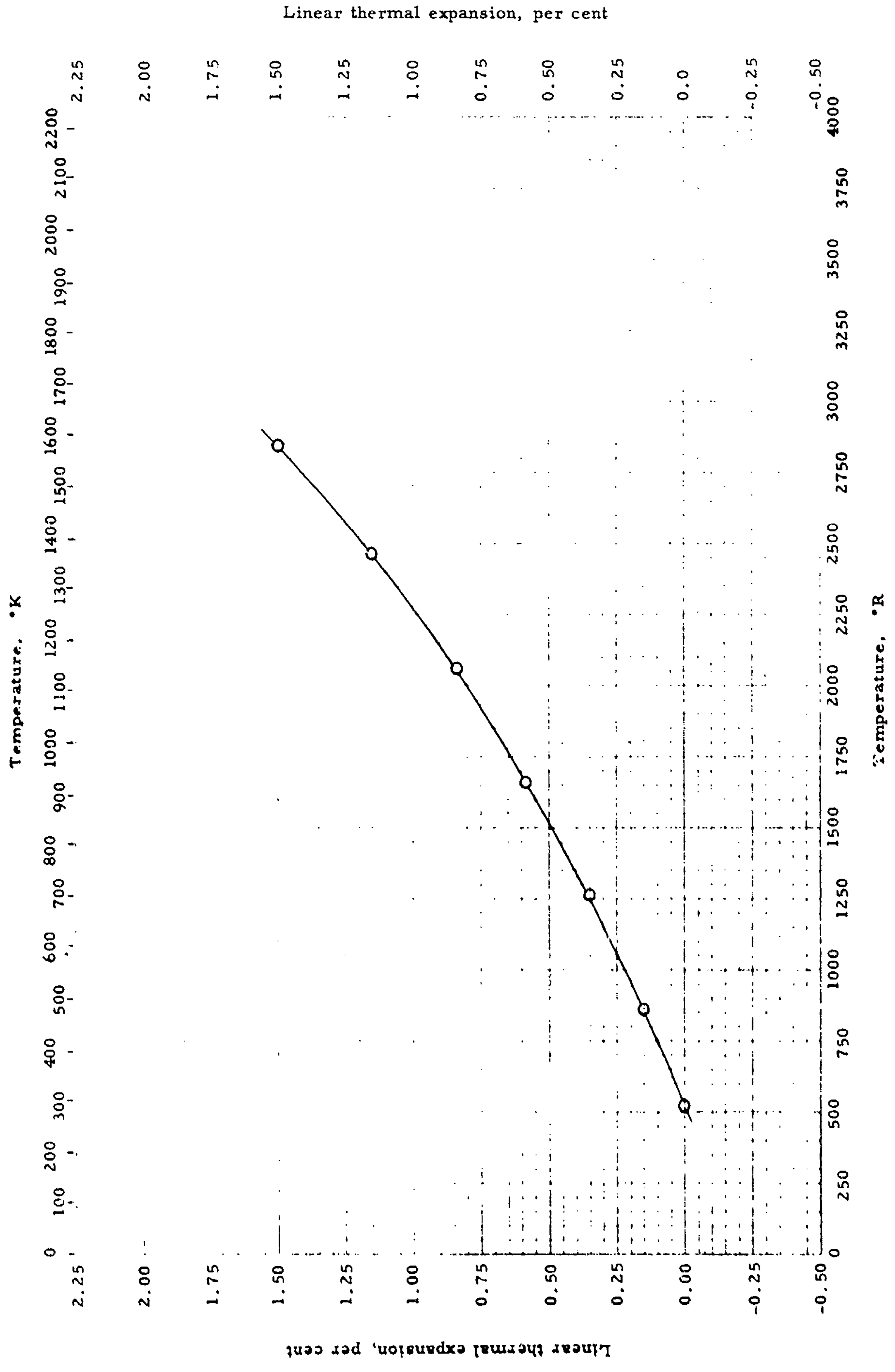


LINEAR THERMAL EXPANSION -- CHROMIUM + MOLYBDENUM + IRON

LINEAR THERMAL EXPANSION -- CHROMIUM + MOLYBDENUM + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Parke, R. M. and Bens, F. P.	46-3	535-2260	60% Cr; 25% Mo; 15% Fe	Not given	As cast
□	Ibid.	46-3	535-2260	Same as above	Same as above	Aged 200 hr. at 1600°F



LINEAR THERMAL EXPANSION -- CHROMIUM + MOLYBDENUM

LINEAR THERMAL EXPANSION -- CHROMIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Shevlin, T. S. and Hauck, C. A.	54-40 also 55-19	528-2460	80% Cr; 20% Mo; prepared from 99+% pure Cr and 99.75+% pure Mo	Telemicroscopes sighting on wires suspended from sample	Initial run discarded as bends in sight wires came out during heating, results given are from cooling curve plus later runs

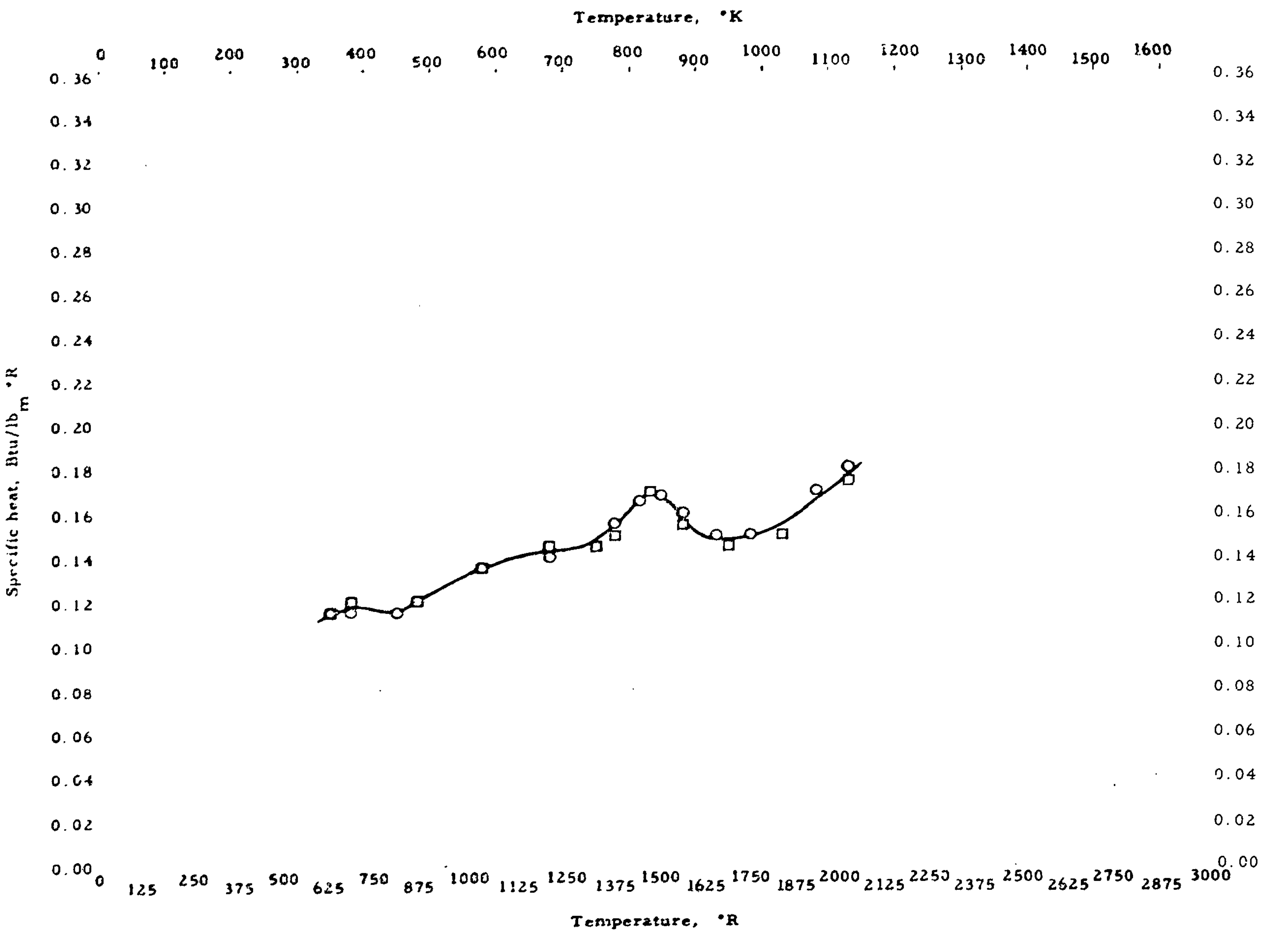
Symbol	Material Analysis, %					Density	
	Cr	W	Fe	Mo	C	lb_m/ft	g/cm^3
○	45	29	23	3	0.05	557.18	8.9251
○	45	29	23	3	0.029	557.19	8.9252
○	47	27	23	3	0.026	548.31	8.7831
○	52	24	22	2	0.018	538.41	8.6244
○	54	22	22	2	0.021	526.21	8.4290
○	56	22	20	2	0.018	525.42	8.4164
○	57	22	21	-	0.021	527.78	8.4541
□	57	22	21	-	0.021	534.82	8.5670
○	57	-	23	20	0.018	483.67	7.7476
○	58	20	20	2	0.018	516.21	8.2688
○	59	20	19	2	0.016	518.78	8.3100
○	60	-	25	15	-	476	7.63
○	60	-	15	25	-	491	7.87
○	70	30	-	-	0.026	542	8.68
○	100	-	-	-	-	445.6	7.138

DENSITY -- CHROMIUM + TUNGSTEN + IRON + X

DENSITY -- CHROMIUM + TUNGSTEN + IRON + X

REFERENCE INFORMATION

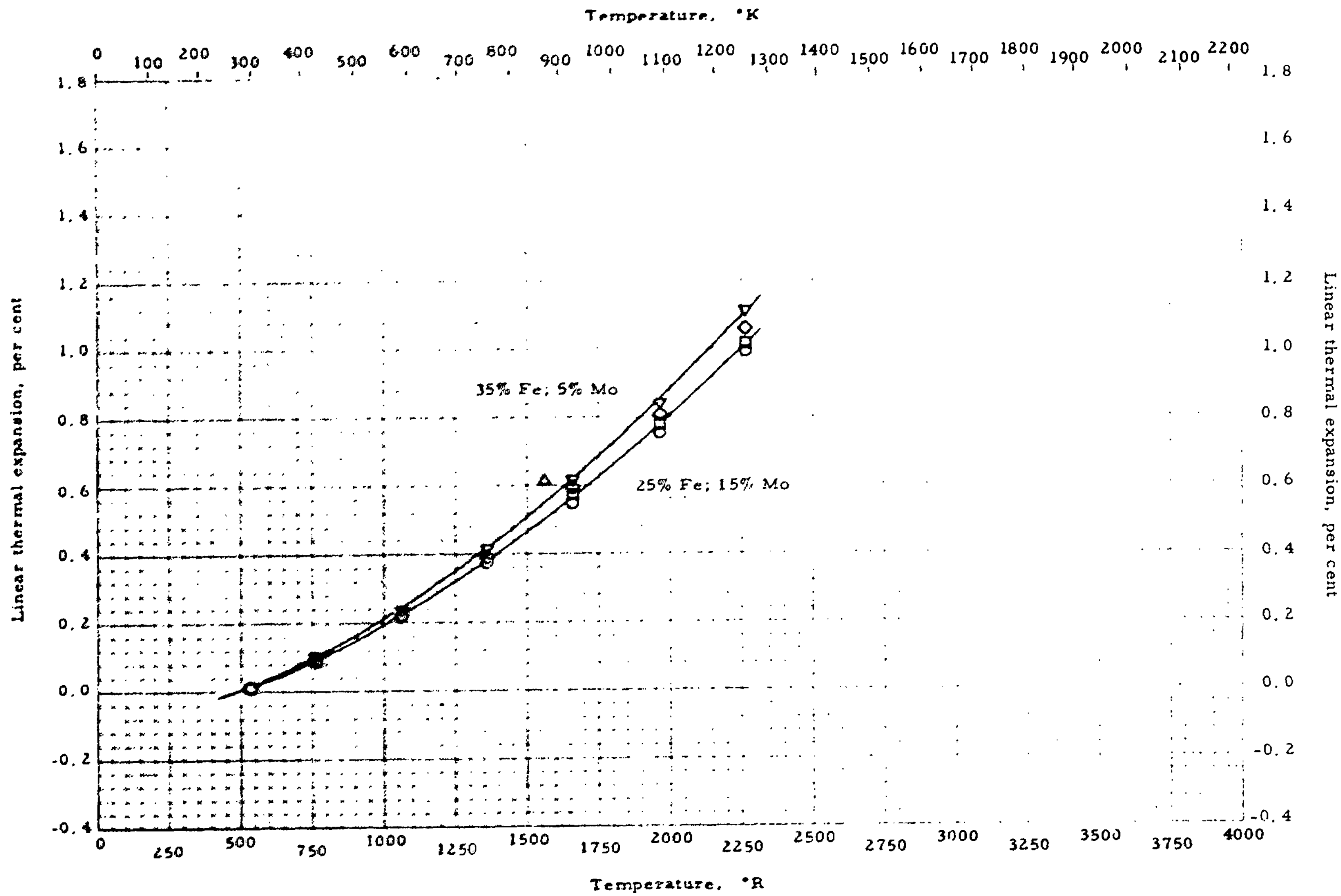
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Parke, R.M. and Bens, F.P.	46-3	Room	Chromium base alloy series: 45 - 70% Cr. for analysis see table on preceding page	ρ: not given	As cast
□	Ibid.	46-3	Room	Same as above	ρ: not given	Cast, held at 2060°R for 324 hr.



SPECIFIC HEAT --CHROMIUM + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Masumoto, H., Saito, H. and Sugihara, M.	53-129	618-2022	55.57% Cr; 0.95% Si; 0.12% Al; 0.041% N; 0.034% C; balance Fe	Comparative, rate of cooling with pure iron standard	Heated 3 hr. at 1000°C in vacuum electric furnace, furnace cooled to 800°C, cooled to room temp. at 30°C/hr
□	Ibid.	53-129	618-2022	53.07% Cr; 0.93% Si; 0.14% Al; 0.077% N; 0.041% C; balance Fe	Same as above	Same as above

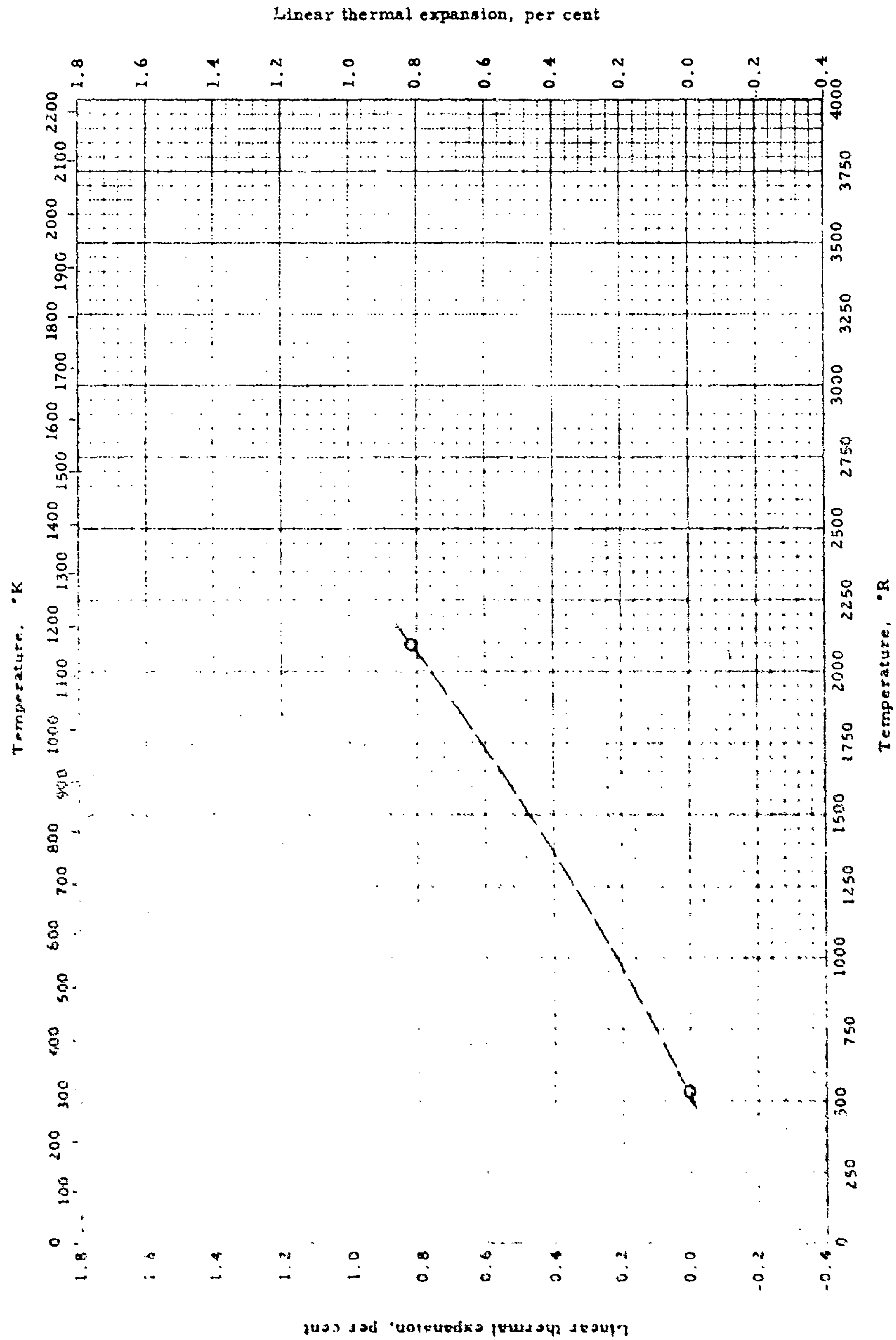


LINEAR THERMAL EXPANSION -- CHROMIUM + IRON + MOLYBDENUM

LINEAR THERMAL EXPANSION -- CHROMIUM + IRON + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Parke, R. M. and Bens, F. P.	46-3	535-2260	60% Cr, 25% Fe; 15% Mo	Not given	As cast
□	Ibid.	46-3	535-2260	Same as above	Same as above	Aged 200 hr. at 1600°F
△	Ibid.	46-3	535-1560	60% Cr; 30% Fe; 10% Mo	Same as above	
◇	Ibid.	46-3	535-2260	60% Cr; 35% Fe; 5% Mo	Same as above	As cast
▽	Ibid.	46-3	535-2260	Same as above	Same as above	Aged 200 hr. at 1600°F

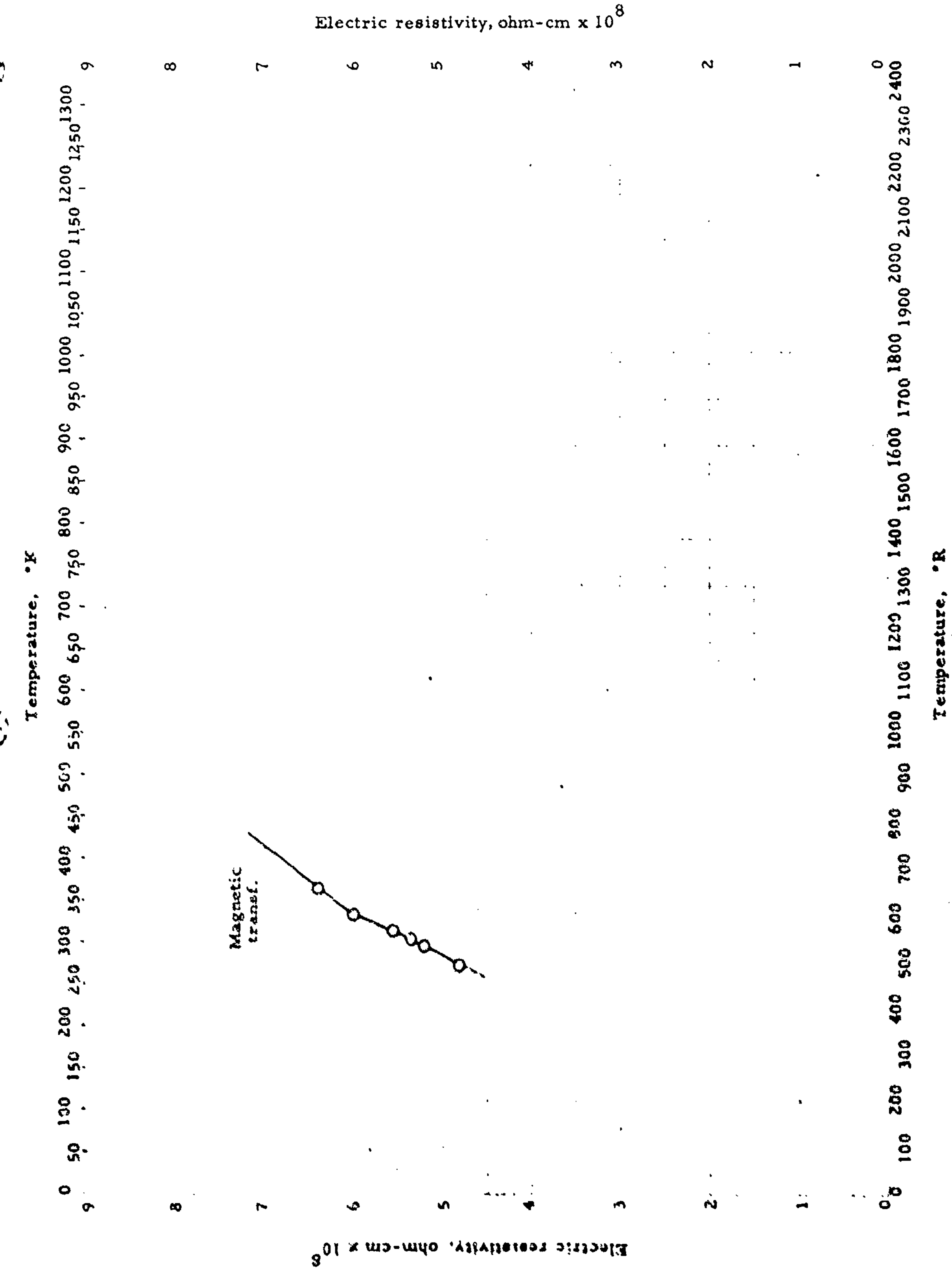


LINEAR THERMAL EXPANSION -- CHROMIUM + TUNGSTEN

LINEAR THERMAL EXPANSION -- CHROMIUM + TUNGSTEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Parke, R.M. and Bens, F.P.	46-3	535-2090	65% Cr; 35% W	Not given	Auth. gives avg. coeff. of exp. = 5.25 x 10^{-6} per °F 75 to 1630°F

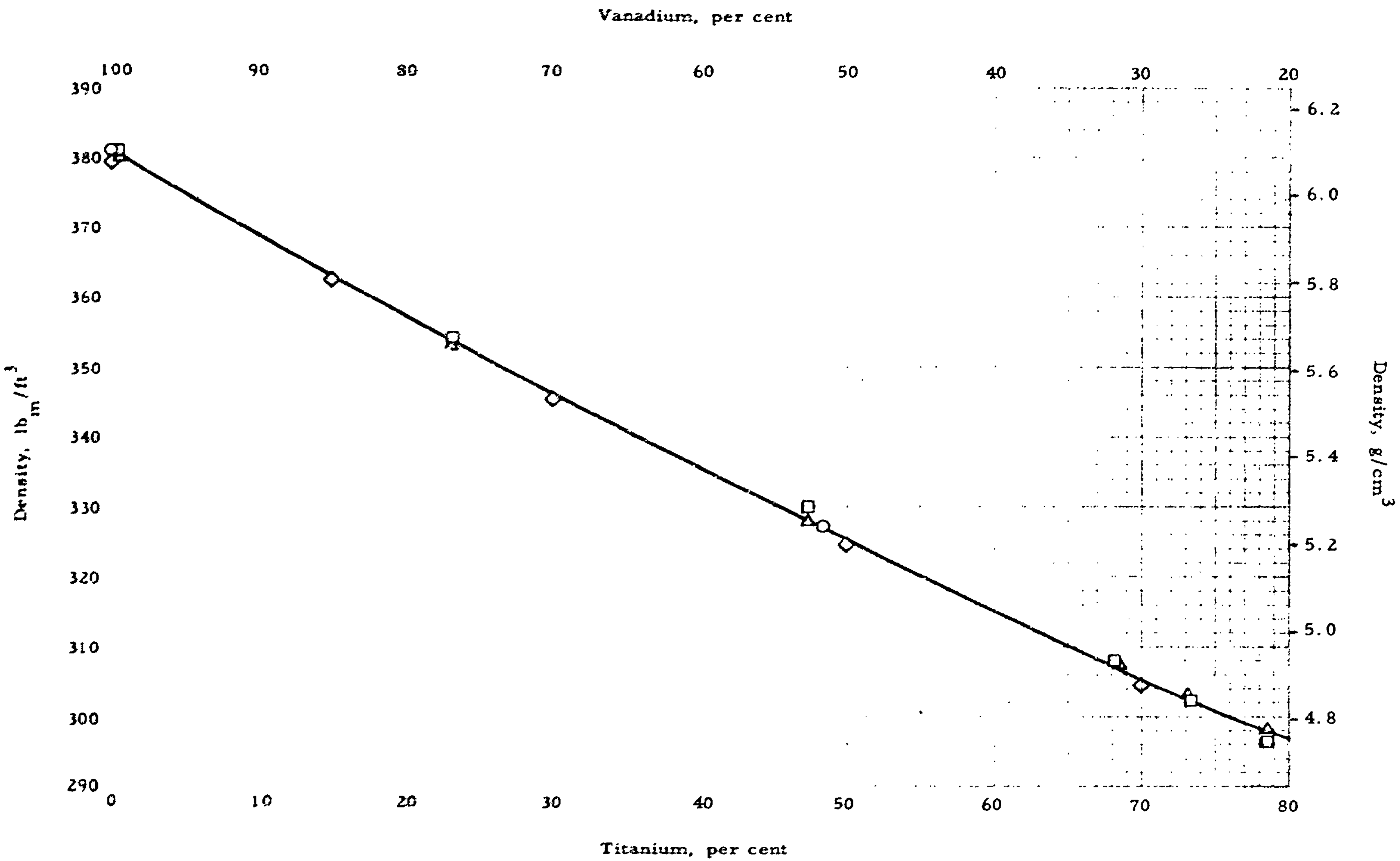


ELECTRIC RESISTIVITY -- CHROMIUM + TELLURIUM

ELECTRIC RESISTIVITY -- CHROMIUM + TELLURIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Fakidov, I. G., Grazhdankina, N. P., Kikoin, A. K.	49-38	492-654	Nominal: 69.79% Te, 30.21% Cr	Not given	Melted in silica tube at 1250°C in A atmos.

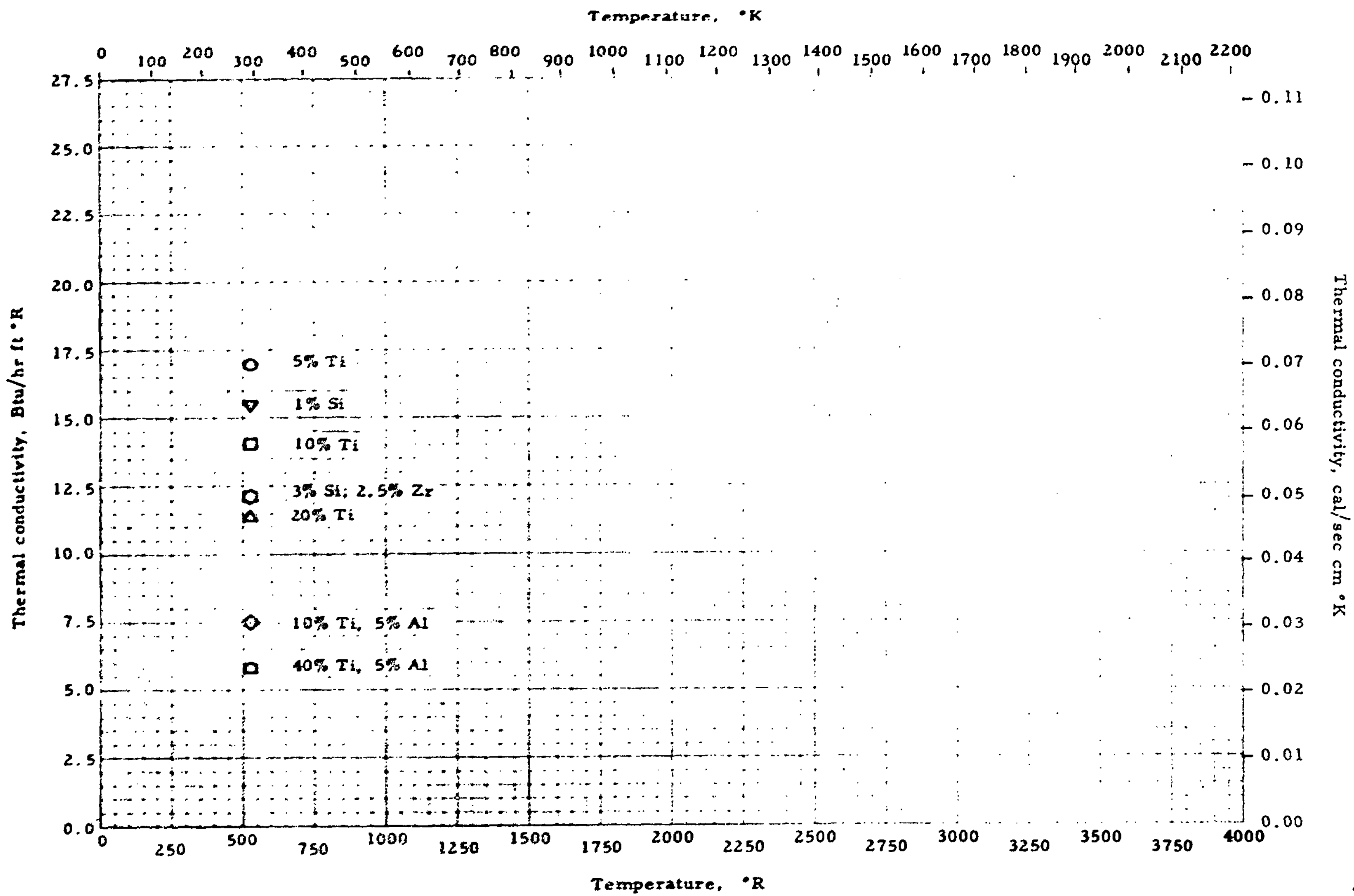


DENSITY -- VANADIUM + TITANIUM

DENSITY -- VANADIUM + TITANIUM

REFERENCE INFORMATION

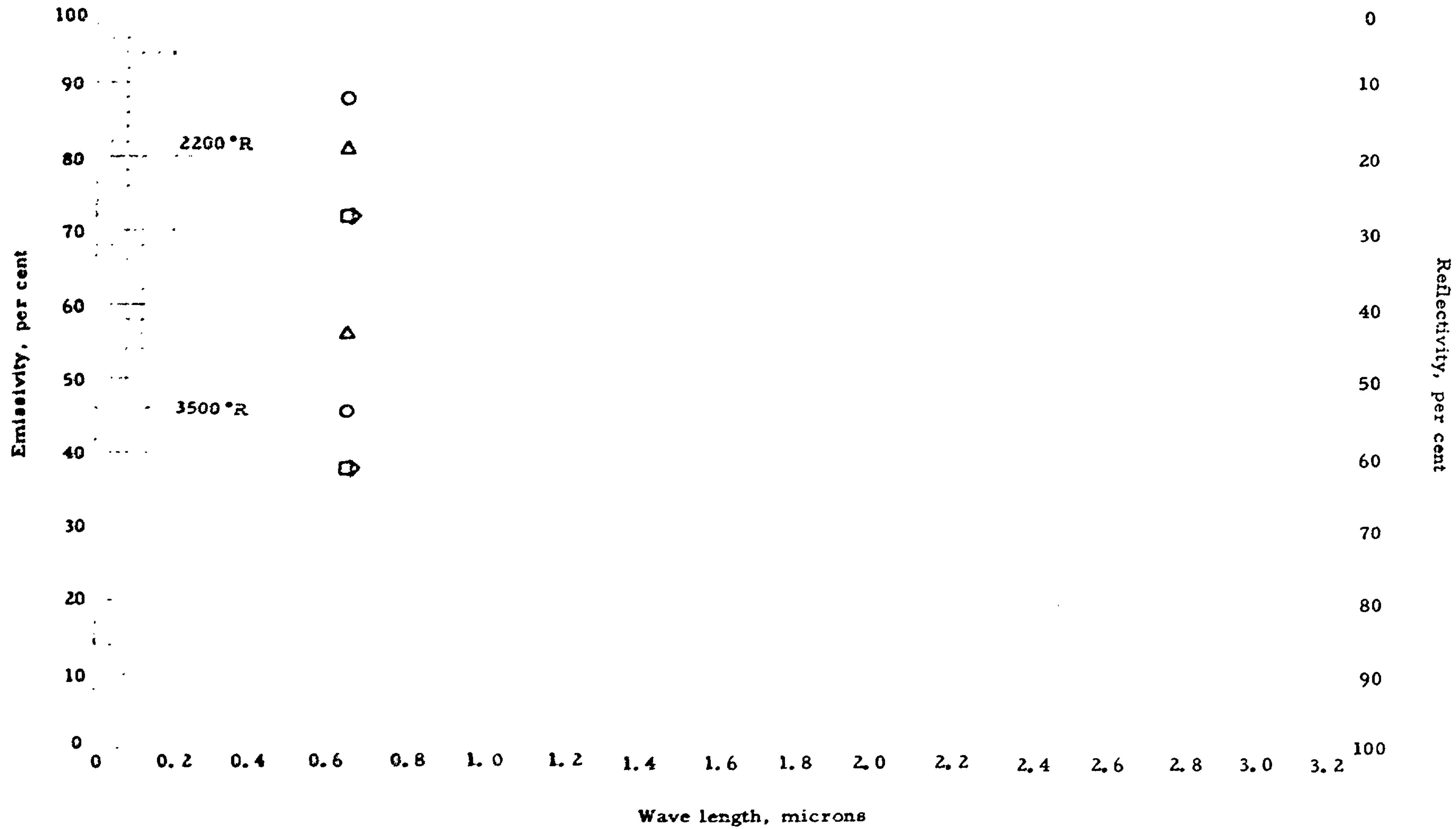
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R.M. and Wilhelm, H.A.	52-17	Room	0 - 48% Ti 0.4% impurities	Weight in air and in water	
□	Ibid	52-17	Room	0 - 78% Ti; 1.8% impurities	Same as above	Hot rolled
△	Ibid	52-17	Room	0 - 78% Ti; 1.8% impurities	Same as above	Arc melted
◇	Ibid	52-17	Room	0 - 70% Ti	Computed from x-ray measurements of lattice	



THERMAL CONDUCTIVITY -- VANADIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Smith, K. F. and Van Thyne, R. J.	57-36	room	95% V, 5% Ti	Not given	
□	Ibid.	57-16	room	90% V, 10% Ti	Same as above	
△	Ibid.	57-36	room	80% V, 20% Ti	Same as above	
▽	Ibid.	57-36	room	99% V; 1% Si	Same as above	
○	Ibid.	57-16	room	94.5% V; 3% Si; 2.5% Zr	Same as above	
◇	Ibid.	57-36	room	85% V; 10% Ti; 5% Al	Same as above	
⌂	Ibid.	57-36	room	55% V; 40% Ti; 5% Al	Same as above	

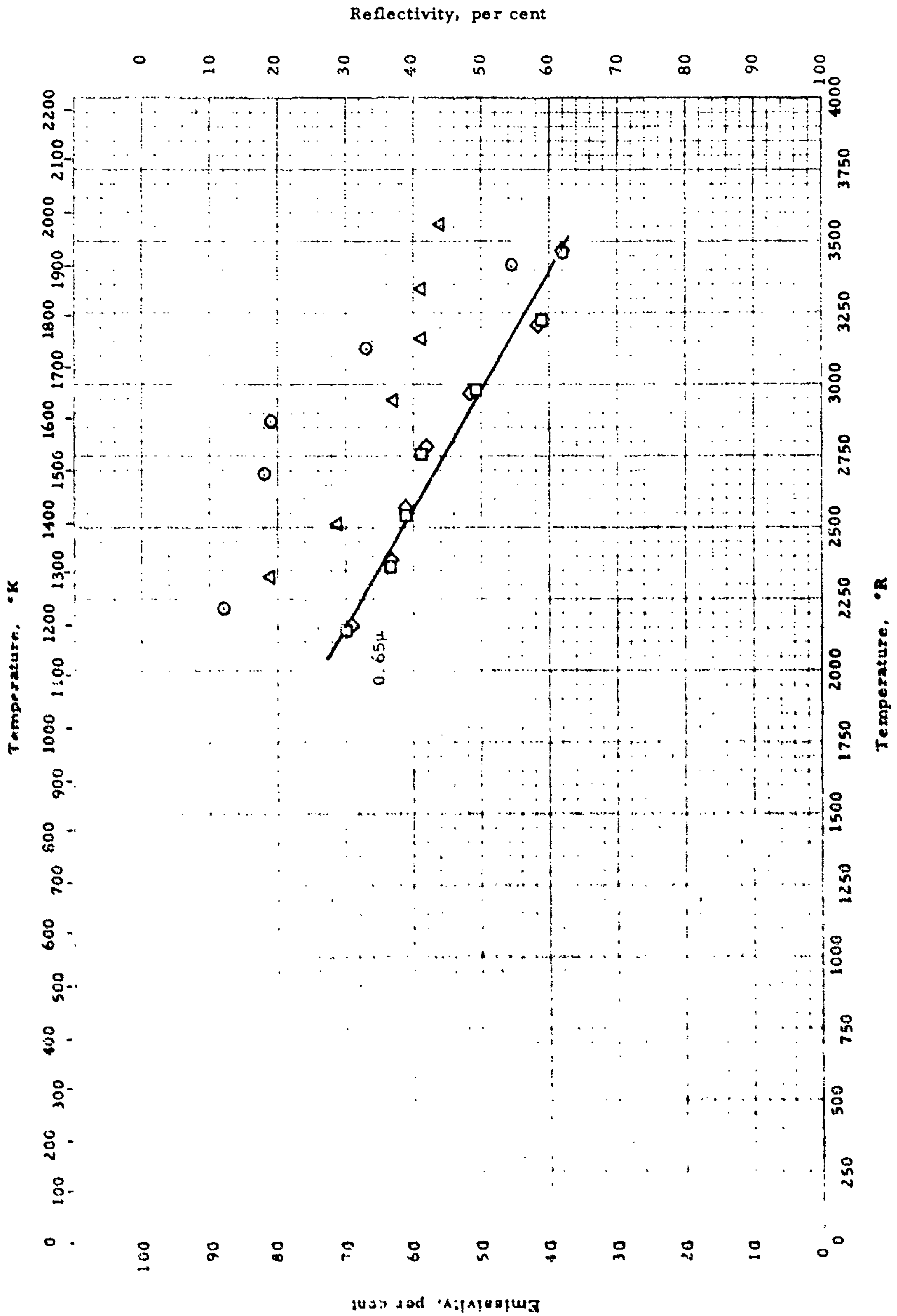


SPECTRAL EMISSIVITY -- VANADIUM + TITANIUM

SPECTRAL EMISSIVITY -- VANADIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R. M. and Wilhelm, H. A.	52-17	2150-3550	68.0% V 32.0% Ti	Spectral normal emissivity at 0.65μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer	Vacuum 11μ Hg
□	Ibid.	52-17	2150-3550	Same as above	Same as above	Same as above, except vac. 0.1μ Hg
△	Ibid.	52-17	2150-3550	51.67% V, 48.33% Ti	Same as above	Same as above, except vac. 11μ Hg
◇	Ibid.	52-17	2150-3550	Same as above	Same as above	Same as above, except vac. 0.1μ Hg

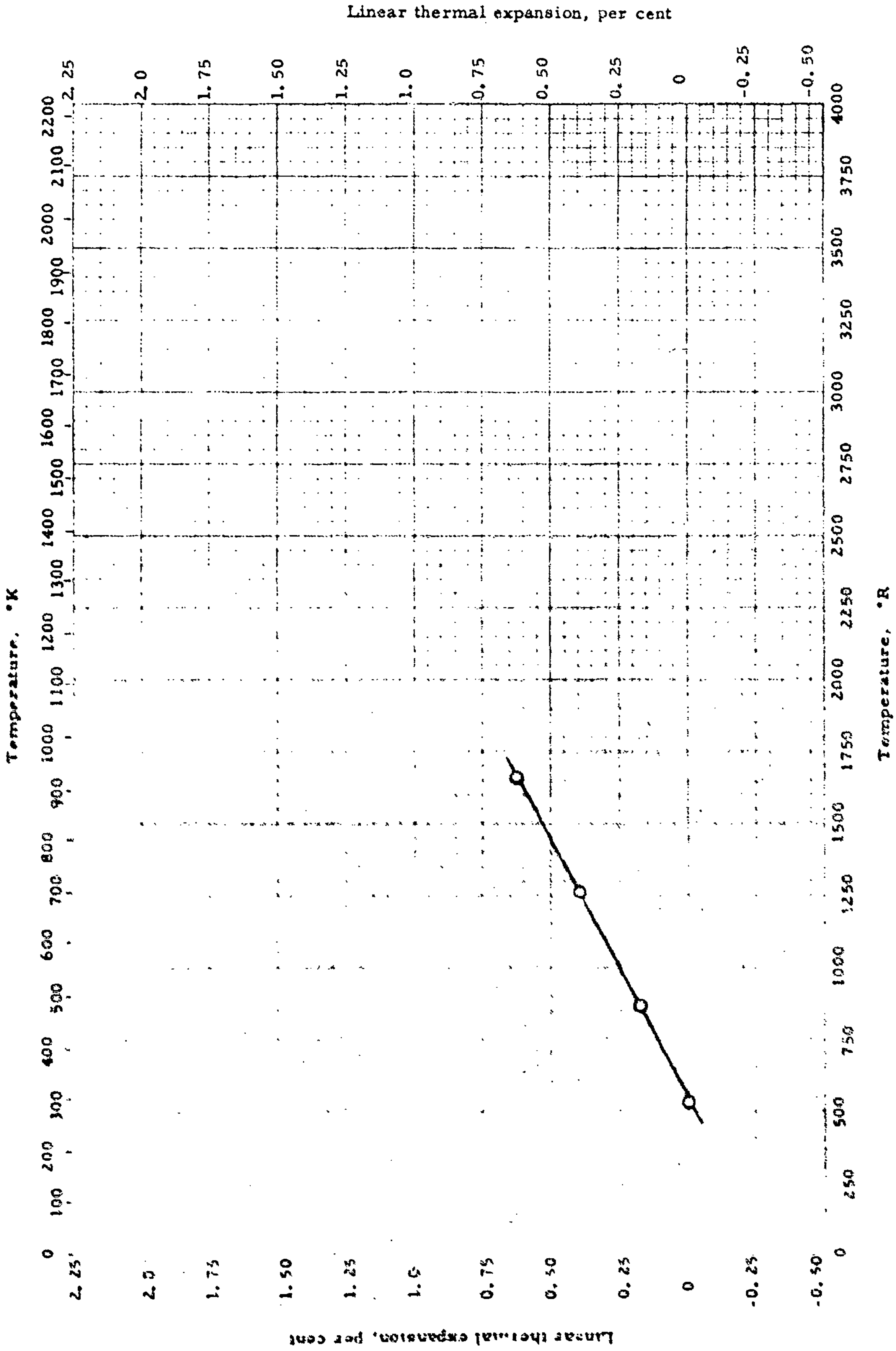


EMISSIVITY -- VANADIUM + TITANIUM

EMISSIVITY -- VANADIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R. M. and Wilhelm, H. A.	52-17	2220-3408	68.0% V; 32.0% Ti	Spectral normal emissivity at 0.65μ, comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer	Tested in vacuum of 11μ Hg
□	Ibid.	52-17	2148-3462	Same as above	Same as above	Same as above, except vacuum 0.1μ Hg
△	Ibid.	52-17	2328-3552	51.67% V; 48.33% Ti	Same as above	Same as above, except vacuum 11μ Hg
◇	Ibid.	52-17	2148-3462	Same as above	Same as above	Same as above, except vacuum 0.1μ Hg

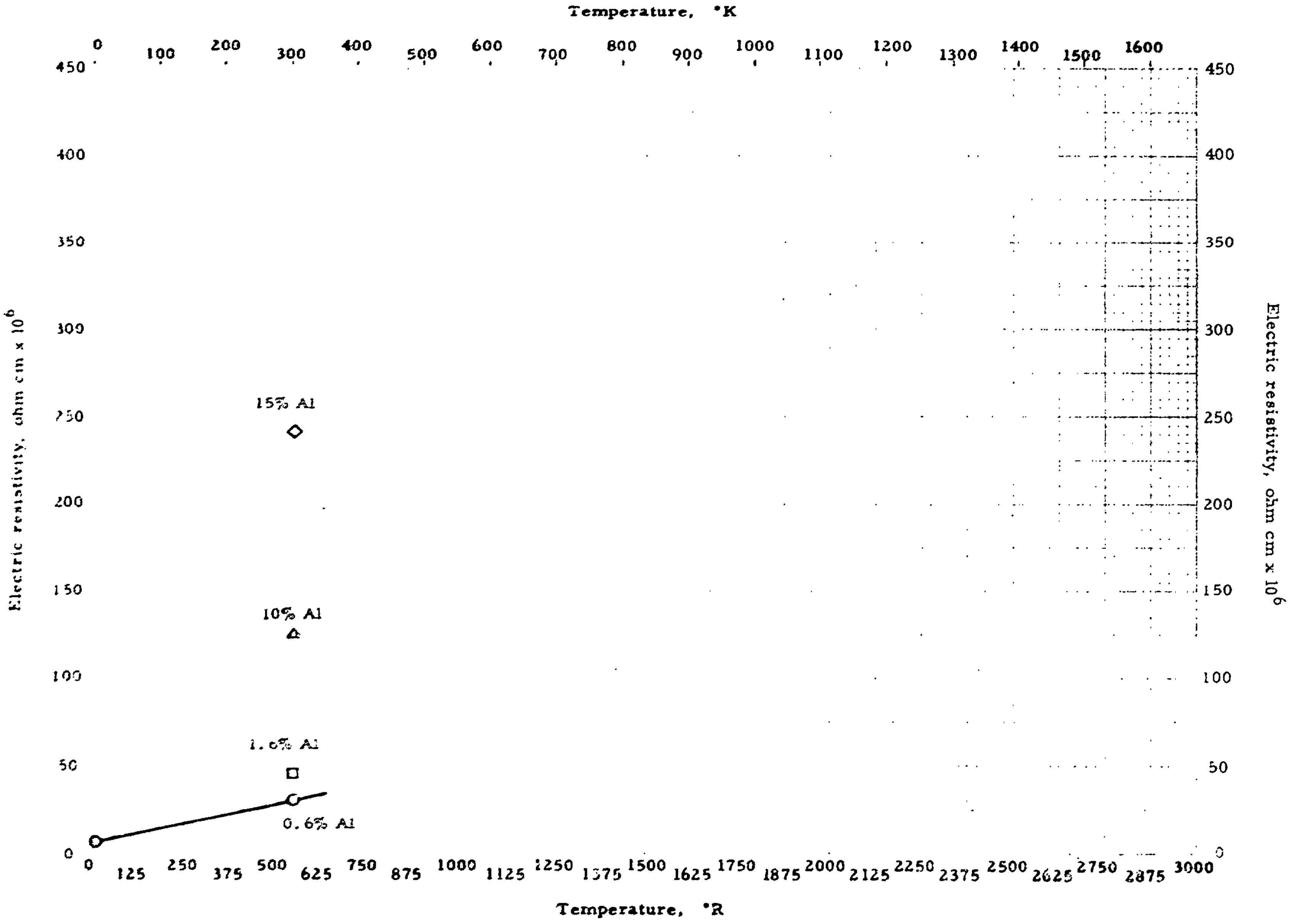


LINEAR THERMAL EXPANSION -- VANADIUM + TITANIUM

LINEAR THERMAL EXPANSION -- VANADIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Adenstedt, H.K., Peguignot, J.R. and Raymer, J.M.	52-118	528-1660	50-90% V. Alloys prepared from 99.9+% pure Ti and 99.8% pure V	Quartz tube dilatometer; Leitz-Bollenrath in vac.	Cast, cold rolled, vac. annealed. Avg. of 4 samples with 50-60, 70 and 90 wt.% V, respectively. Max. dev. ± 1%

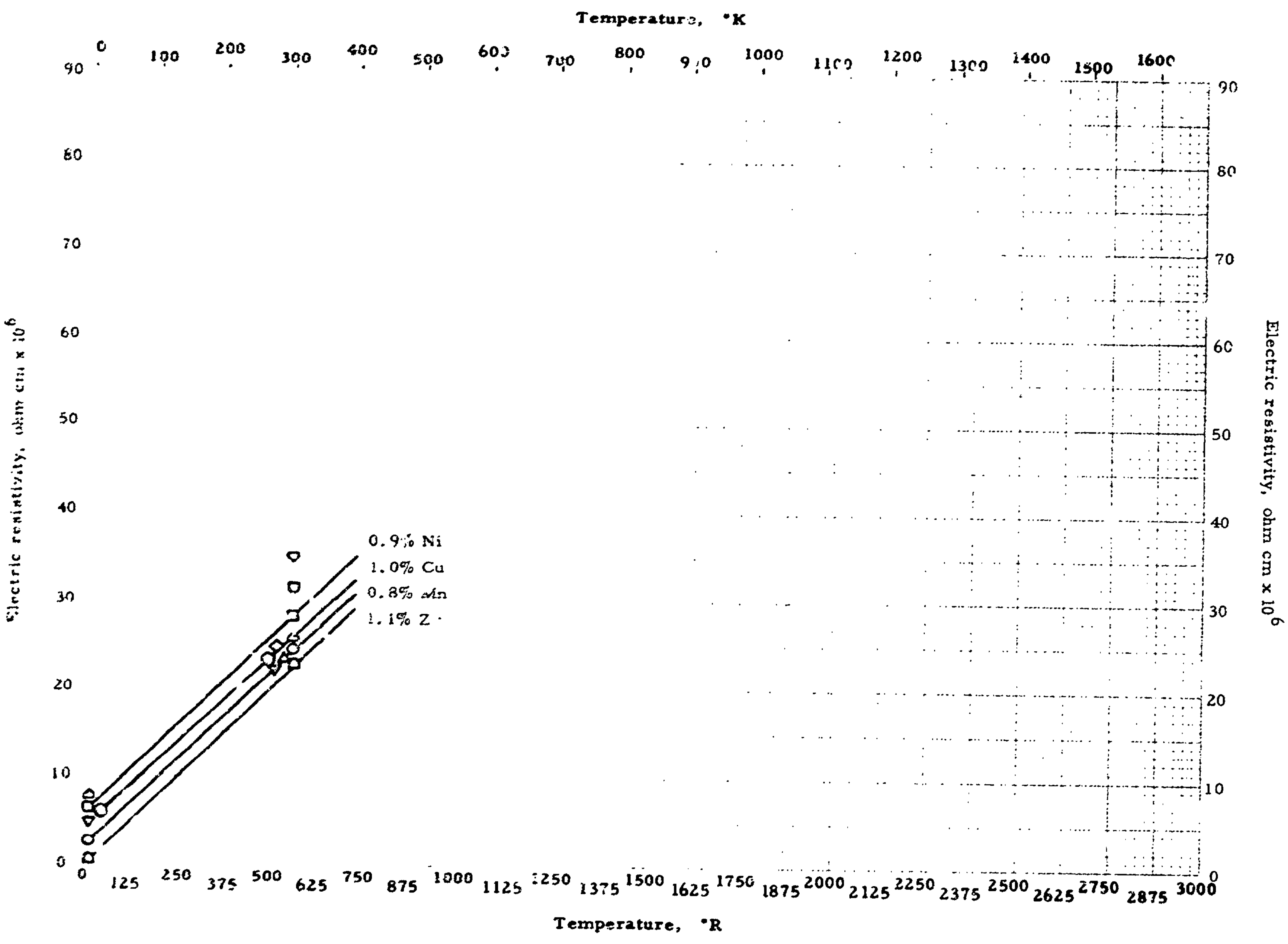


ELECTRIC RESISTIVITY -- VANADIUM + ALUMINUM

ELECTRIC RESISTIVITY -- VANADIUM + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cleary, H. J.	56-4	8-547	0.60% Al	Potential drop	Auth. est. accuracy ± 10%
□	Ibid.	56-4	547	1.61% Al	Same as above	Same as above
△	Ibid.	56-4	547	9.97% Al	Same as above	Same as above
◇	Ibid.	56-4	547	15.00% Al	Same as above	Same as above

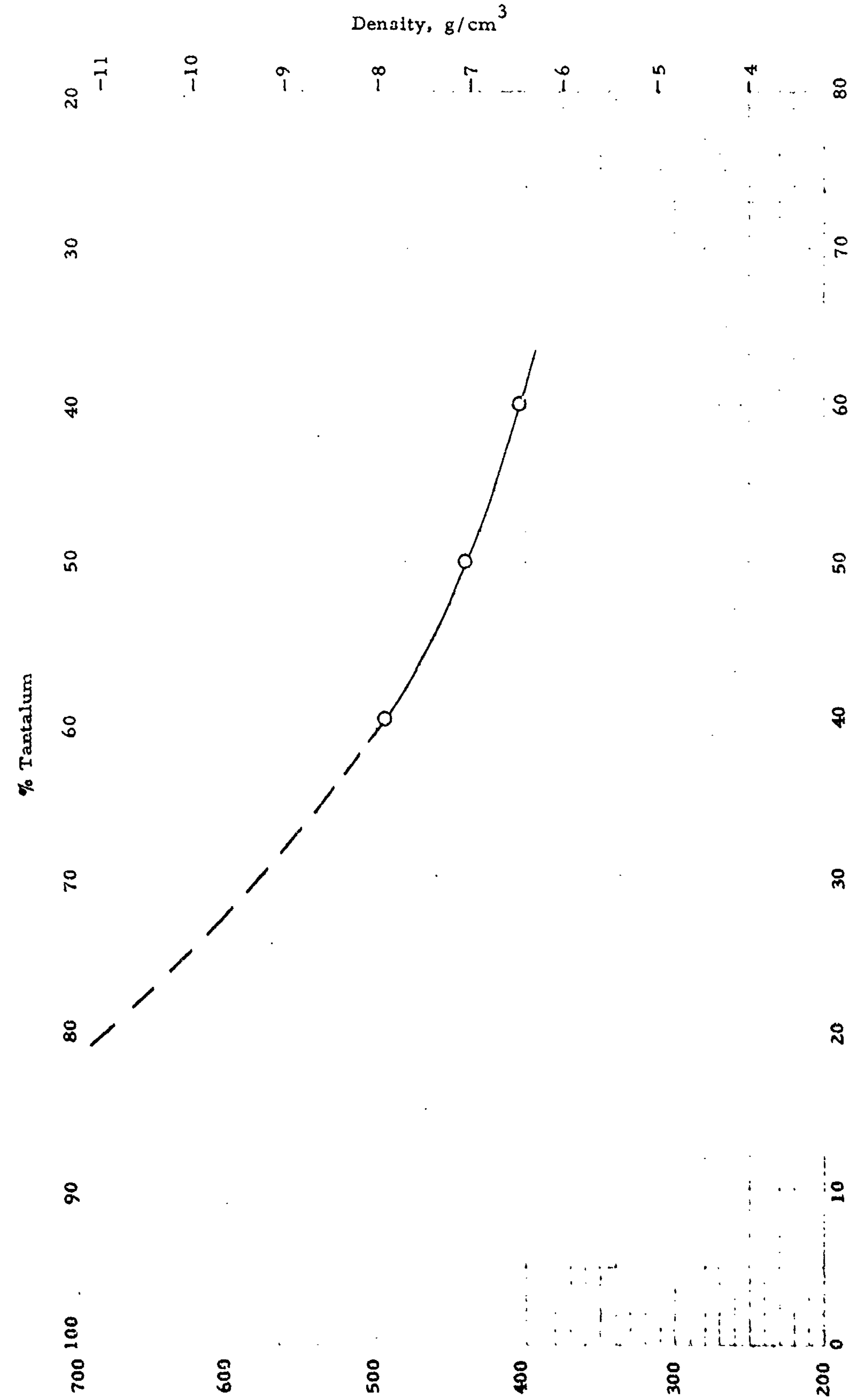


ELECTRIC RESISTIVITY -- VANADIUM + X

ELECTRIC RESISTIVITY -- VANADIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Cleary, H. J.	56-4	8-547	0.80% Mn	Potential drop	Auth est. accuracy ± 10% for values at room temp.
□	Ibid	56-4	8-547	0.94% Ni	Same as above	Same as above
△	Ibid	56-4	8-547	0.98% Ti	Same as above	Same as above
◇	Ibid	56-4	8-547	0.99% Cr	Same as above	Same as above
▽	Ibid	56-4	8-547	1.00% Fe	Same as above	Same as above
○	Ibid	56-4	8-547	1.00% Cu	Same as above	Same as above
◠	Ibid	56-4	8-547	1.09% Zr	Same as above	Same as above
△	Ibid	56-4	8-547	2.05% Pd	Same as above	Same as above
◡	Ibid	56-4	8-547	2.12% Sb	Same as above	Same as above
▽	Ibid	56-4	8-547	2.30% Sn	Same as above	Same as above



DENSITY -- TANTALUM + TITANIUM

DENSITY -- TANTALUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Maykuth, D. J., Ogden, H. R. et al.	54-57	Room	Alloy series 40-60% Ti	ρ: weight in air and water	

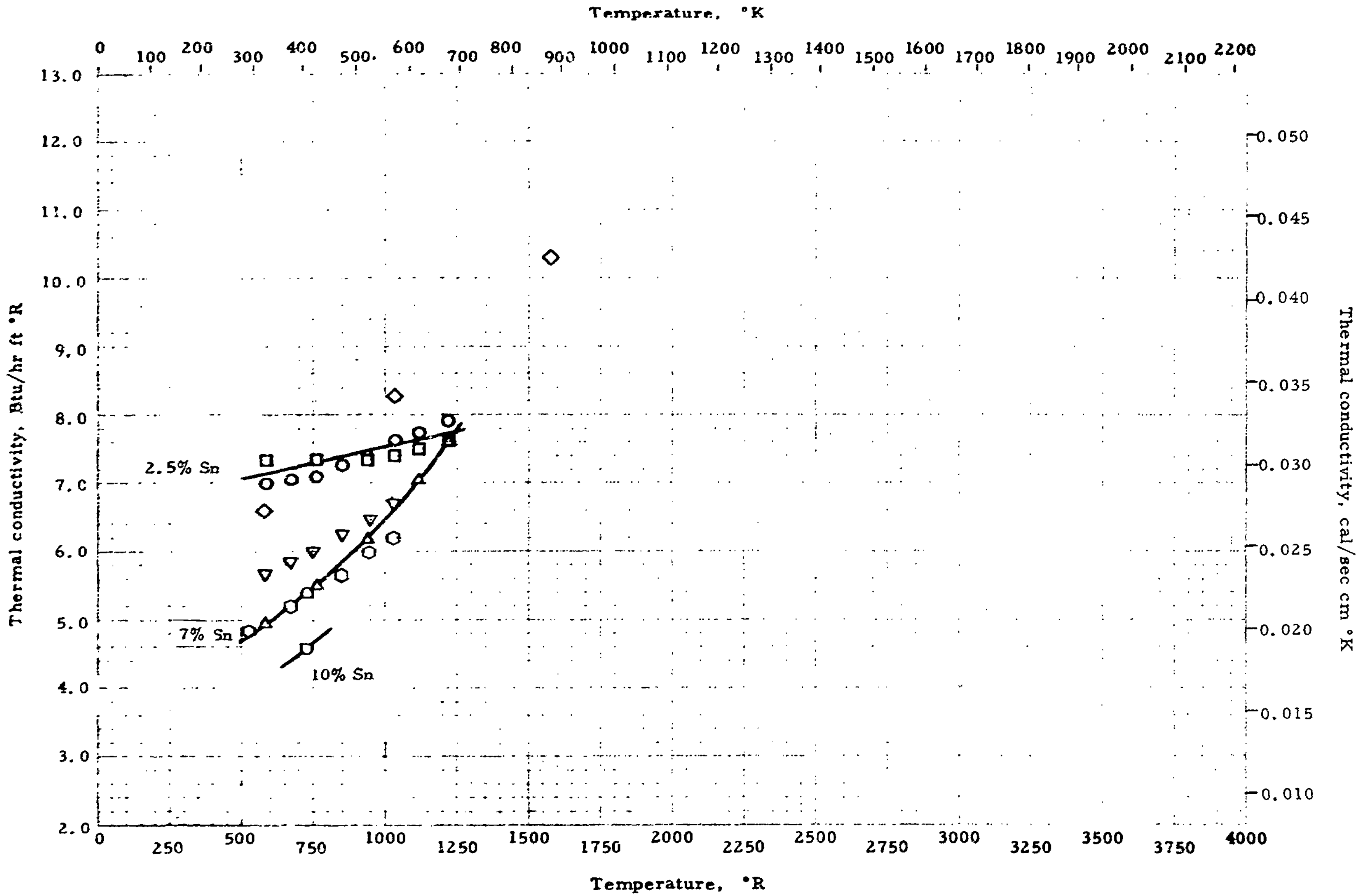
Symbol	Material Composition % Sn	Density lb_m/ft^3	Density g/cm^3
O	1.36	404.46	6.4789
	1.40	408.27	6.5399
	1.46	405.03	6.4880
	1.54	406.81	6.5164
	1.58	405.66	6.4789

DENSITY -- ZIRCONIUM + TIN + X

DENSITY -- ZIRCONIUM + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Beard, A.P., Harrison, J.W. and Clark, W.B.	57-76	Room	Alloy series from 1.36 to 1.58% Sn	ρ: weight and volume by CCl_4 displacement	Alloys made by two consumable electrode melts in sequence in arc furnace with He atm., extruded repeatedly. Density data reported are avg. of 2 - 4 tests each

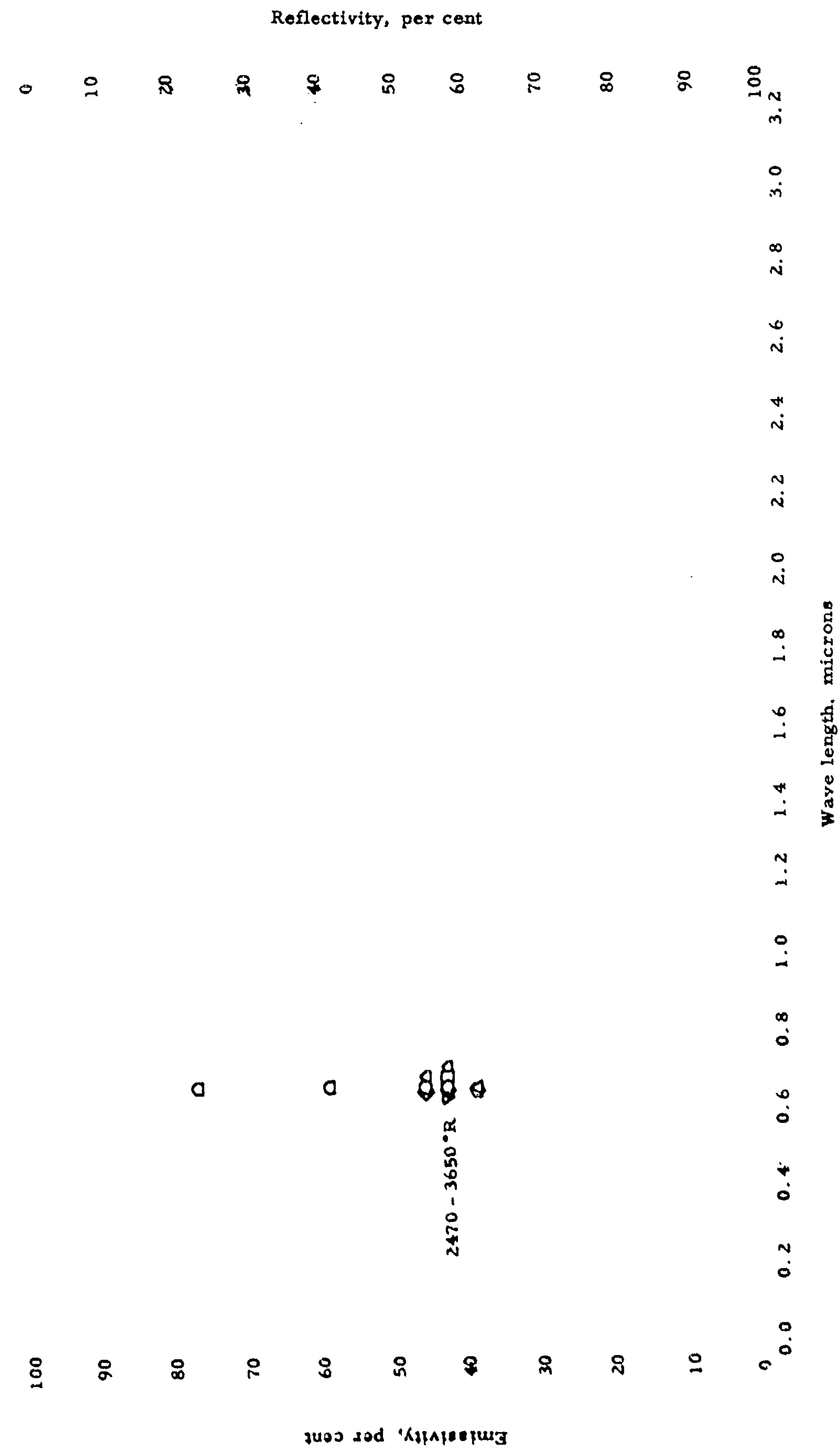


THERMAL CONDUCTIVITY -- ZIRCONIUM + TIN

THERMAL CONDUCTIVITY -- ZIRCONIUM + TIN

REFERENCE INFORMATION

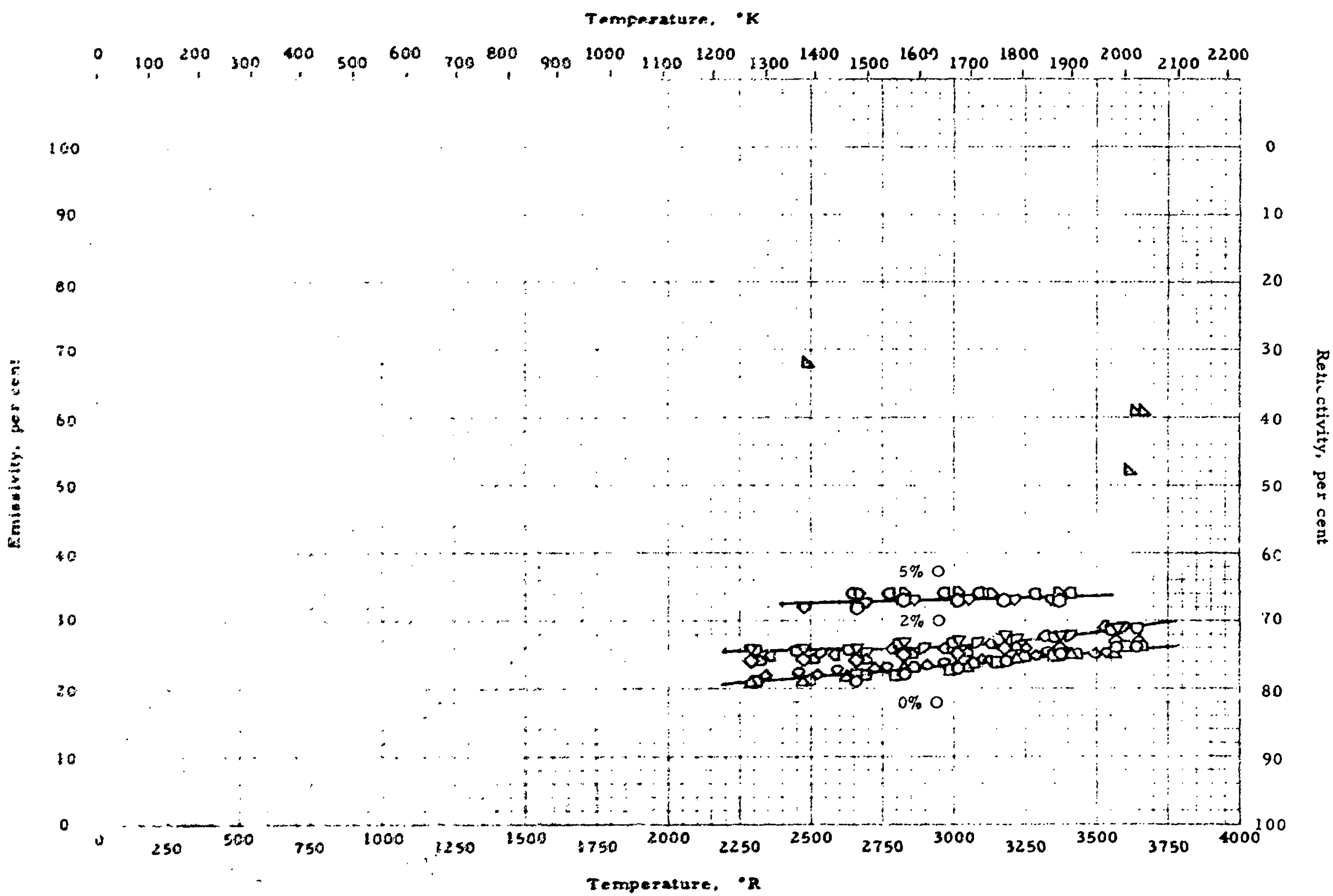
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W.	53-46	582-1212	2.5% Sn; 0.002% N_2; prepared from sponge Zn	Comparative; rods (Armco Iron standard)	Arc melted, forged, rolled at 1600 °F
□	Ibid.	53-46	582-1212	2.51% Sn; 0.005% N_2; prepared from WAPD Grade I; crystal bar Zr and c.p. tin	Same as above	Arc melted, forged at 1700 °F
△	Ibid.	53-46	582-1212	7% Sn; prepared from Foote Grade I crystal bar and c.p. tin	Same as above	Arc melted
◇	Moss, M.	55-6	582-1572	3% Sn	Axial heat flow in rod. Guarded sample, calorimeter sink	Double melted
▽	Bing, G., Fink, F. W. and Thompson, H. B.	51-64	582-1032	4.85% Sn; 0.23% Fe; 0.12% C; 0.024% Hf; 0.014% Ti; 0.009% Al; 0.007% N; 0.006% Ni	Comparative; rods	Auth. est. accuracy ± 3%. From low Hf crystal bar Zr. Double arc melted, forged 1650 °F
○	Ibid.	51-64	582-1032	Nominal: 95% Zr; 5% Sn	Same as above	Auth. est. accuracy ± 3%. Induction melted in graphite from low Hf sponge. Forged at 1800 °F in air
◠	Smith, K. F. and Chiswik, H. H.	56-113	733	7% Sn	Comparison type apparatus heated in NaK bath	
⊃	Ibid.	56-113	727	10% Sn	Same as above	



SPECTRAL EMISSIVITY -- ZIRCONIUM + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lemmon Jr., A. W., Wood, W. D. et al.	57-164	2472-3552	Zircaloy B	Spectral normal emissivity: comparative: surface brightness compared with that of a black body hole	As received
□	Ibid.	57-164	3012	Same as above plus 0.9% O_2	Same as above	Oxygen added by diffusion
△	Ibid.	57-164	3012	Same as above plus 1.9% O_2	Same as above	Same as above
◇	Ibid.	57-164	2472-3552	Zircaloy 2. Nominal: 1.2 - 1.7% Sn; 0.07 - 0.2% Fe, 0.05 - 0.15% Cr; 0.02 - 0.08% Ni	Same as above	As received
▽	Ibid.	57-164	3012	Same as above plus 0.9% O_2	Same as above	Oxygen added by diffusion
○	Ibid.	57-164	3012	Same as above plus 1.9% O_2	Same as above	Same as above
◻	Ibid.	57-164	2472-3552	Zircaloy 2	Spectral emissivity: comparative: surface brightness compared with that of a standard (graphite)	Auth. believes values to be high because of oxide patches
◻	Dayton, R. W. and Tipton Jr., C. R.	56-118 also 57-1[illegible]	2652-3642	Zircaloy 2. Nominal: 1.2 - 1.7% Sn; 0.07 - 0.2% Fe, 0.05 - 0.15% Cr, 0.02 - 0.08% Ni	Spectral emissivity: comparative: surface brightness compared with that of a black body hole	Measured by Lucks, C. F., Wood, W. D. et al.

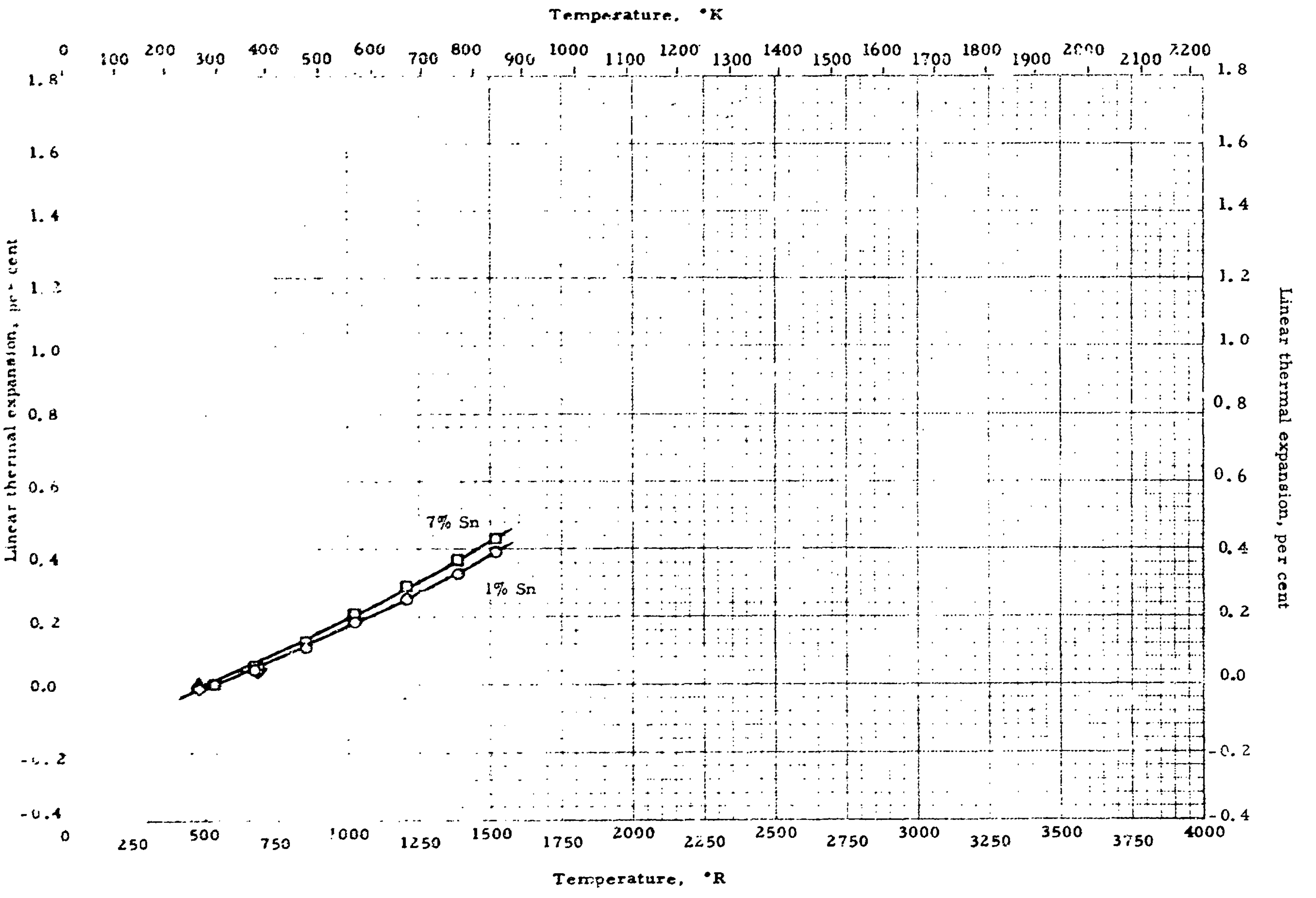


EMISSIVITY -- ZIRCONIUM + TiN + X

EMISSIVITY -- ZIRCONIUM + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dayton, R. W. and Tipton, C. R.	56-118 also 57-163	2652-3642	Zircaloy 2. Nominal: 1.2 - 1.7% Sn; 0.07 - 0.2% Fe; 0.05 - 0.15% Cr; 0.03 - 0.08% Ni	Total emissivity: Comparative: surface brightness compared with that of a black body hole.	Measured by C.F. Lucks, G. B. Haines, et. al.
□	Ibid.	56-118 also 57-163	2652-3642	Same as above	Total emissivity: Surface brightness compared with that of a wire loop considered to approach a black body.	Same as above
△	Dayton, R. W. and Tipton, C. R.	57-154	2292-3552	Zircaloy 2. Nominal: 1.2 - 1.7% Sn; 0.07 - 0.2% Fe; 0.05 - 0.15% Cr; 0.03 - 0.08% Ni	Same as above	Measured by C. F. Lucks, G. B. Haines, et. al.
<	Ibid.	57-154	2292-3552	Zircaloy 2 + 1.4% O	Same as above	Same as above
▽	Ibid.	57-154	2292-3552	Zircaloy 2 + 3.0% O	Same as above	Same as above
○	Ibid.	57-154	2652-3372	Zircaloy 2 + 7.0% O	Same as above	Same as above
◇	Ibid.	57-154	2472-3552	Zircaloy B	Same as above	Same as above
▽	Ibid.	57-154	2472-3552	Zircaloy B +1.4% O	Same as above	Same as above
▷	Ibid.	57-154	2652-3372	Zircaloy B +7.0% O	Same as above	Same as above
○	Lemmon Jr., A. W., Wood W. D. et. al.	57-164	2292-3642	Zircaloy 2. Nominal: 1.2 - 1.7% Sn; 0.07 - 0.2% Fe; 0.05 - 0.15% Cr; 0.03 - 0.08% Ni	Total normal emissivity: Comparative: surface brightness compared with that of a black body hole.	As received
△	Ibid.	57-164	2292-3642	Zircaloy 2 + 0.9% O	Same as above	Oxygen added by diffusion
□	Ibid.	57-164	2292-3642	Zircaloy 2 + 1.9% O	Same as above	Same as above
▽	Ibid.	57-164	2292-3642	Zircaloy 2 + 4.2% O	Same as above	Same as above
△	Ibid.	57-164	2496-2630	Zircaloy 2	Total normal emissivity: Comparative: surface brightness compared with that of a standard (graphite)	[illegible]thor believes values to be high [illegible]ause of oxide patches.
◇	Ibid.	57-164	2290-3550	Zircaloy B	Total normal emissivity: Comparative: surface brightness compared with that of a black body hole.	
○	Ibid.	57-164	2290-3550	Zircaloy B + 0.9% O	Same as above	Oxygen added by diffusion
□	Ibid.	57-164	2290-3550	Zircaloy B + 4.2% O	Same as above	Same as above

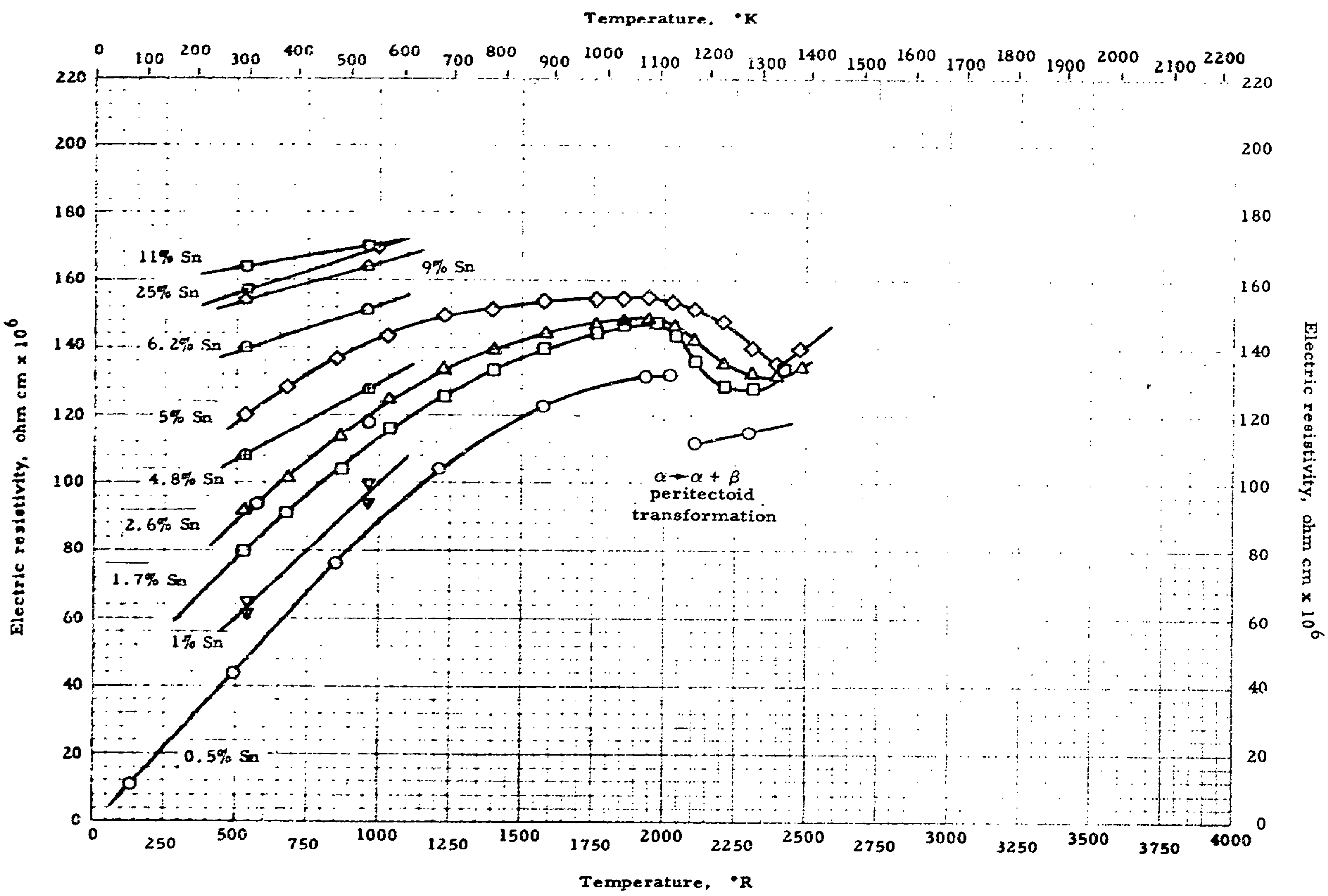


LINEAR THERMAL EXPANSION -- ZIRCONIUM + TIN + X

LINEAR THERMAL EXPANSION -- ZIRCONIUM + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Moskowitz, M. and Kates, L. W.	52-47	546-1518	99% Zr, 1% Sn	Quartz tube dilatometer with dial gauge. Chromel-Alumel thermocouple	Heated in Argon at 25 °C/min. 325 mesh powders pressed at 75 tsi, sintered 10 hr. at 1270 °C in vacuum
□	Ibid.	52-47	546-1518	93% Zr, 7% Sn	Same as above	Same as above. Authors also meas. samples with 3% Sn and with 5% Sn content, with expansion intermediate between values of samples ○ and □
△	Balluffi, R. W., Resnick, R. and Timper, A. J.	52-76	492-2472	99% Zr, 1% Sn; 0.47% O_2; 0.02% Ni; < 0.05% Hf	Quartz tube dilatometer. Temp. by Chromel-Alumel thermocouple	325 mesh powdered Zr hydride and Sn powder pressed, sintered in vacuum. Heated, cooled at 5°C/min.
◇	Ibid.	52-76	492-672	97% Zr, 3% Sn; 0.4% O_2; 0.02% N_2; <0.05% Hf	Same as above	Same as above
▽	Ibid.	52-76	492-672	95% Zr, 5% Sn; 0.4% O_2, 0.02% N_2; <0.05% Hf	Same as above	Expansion intermediate between values of samples △ and □
C	Ibid.	52-76	492-672	93% Zr, 7% Sn; 0.4% O_2; 0.02% N_2; <0.05% Hf	Same as above	

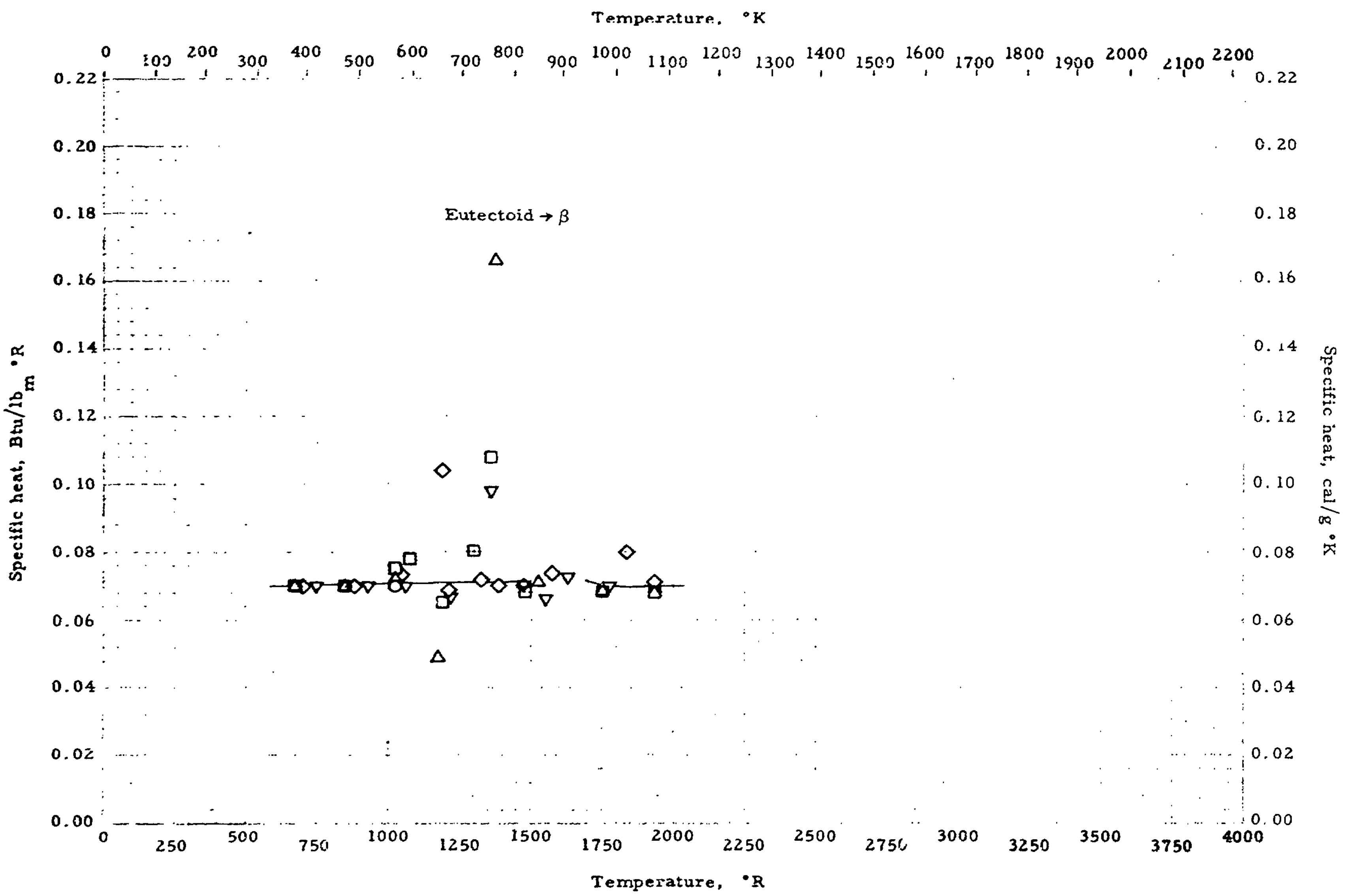


ELECTRIC RESISTIVITY -- ZIRCONIUM + TIN

ELECTRIC RESISTIVITY -- ZIRCONIUM + TIN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bostrom, W.A.	57-100	132-2292	Zirconium Alloy: 0.49% Sn; <0.05% Hf; 0.02% Fe; 0.08% O_2; 0.01% C	Kelvin double bridge	
□	Sailer, H.A. and Dickerson, R.F.	54-20	528-2382	Zircaloy 2: 1.67% Sn; 0.20% Fe; 0.10-0.11% Cr; 0.05% Ni; 0.17-0.20% C	Potential drop	Auth. est. accuracy + 2%; melted in vacuum induction furnace. forged at 900°C; rolled at 815-840°C
△	Ibid.	54-20	528-2382	Sponge Zirconium; 2.58-2.65% Sn; 0.16-0.21% C; 0.009% N	Same as above	Auth. est. accuracy + 2%; melted in vacuum induction furnace; forged at 900-925°C. Rolled at 815-840°C
◇	Ibid.	54-20	528-2382	Sponge Zirconium: 4.80-4.93% Sn; 0.17-0.25% C; 0.009% N	Same as above	Auth. est. accuracy + 2%; melted in vacuum induction furnace; forged at 980-1000°C; rolled at 840-870°C
▽	Bing, G., Fink, F.W. and Thompson, H.B.	51-64	537-960	1% Sn. Actual: ▽, 1.00% Sn; 0.155% Fe; 0.022% Hf; 0.013% C; 0.009% Al; 0.005% N; <0.001% Ti. ▽, 1.03% Sn; 0.019% C; 0.006% N	Potential drop	▽ ▽ extreme values for 6 samples of various comp. and treatments. Auth. est. accuracy ± 1%
○	Ibid.	51-64	537-960	3% Sn. Actual: 2.97 - 3.02% Sn; 0.04 - 0.185% Fe; 0.03 - 0.085% Hf; <0.1% total of C, Ti, Al, N	Same as above	Mean values within a spread of ± 2% for 4 samples of various comp. and treatments. Auth. est. accuracy ± 1%
◠	Ibid.	51-64	537-960	5% Sn. Actual: ◠, 4.85% Sn; 0.12% C; <0.1% total of Fe, Hf, Ti, Al, N, Ni. ◠, 6.20% Sn; 0.8% Hf; 0.37% C; 0.13% Fe; <0.1% total N, Al, Ti	Same as above	◠ ◠ extreme values for 8 samples of various composition and treatments. Auth. est. accuracy ± 1%
△	Ibid.	51-64	537-960	10% Sn. Actual: 8.94% Sn; 0.80% Hf; 0.34% C; 0.13% Fe; 0.035% Al, 0.026% N; 0.004% Ti	Same as above	Induction melted, tested as cast. Auth. est. accuracy ± 1%
◡	Ibid.	51-64	537-960	15% Sn; Actual: 10.8% Sn; 0.80% Hf; 0.35% C; 0.14% Fe; 0.03% Al; 0.027% N; 0.004% Ti	Same as above	Same as above
◇	Ibid.	51-64	537-960	25% Sn. Actual: 24.6% Sn; 0.79% Hf; 0.30% C; 0.14% Fe; 0.035% Al; 0.029% N; 0.004% Ti	Same as above	Same as above

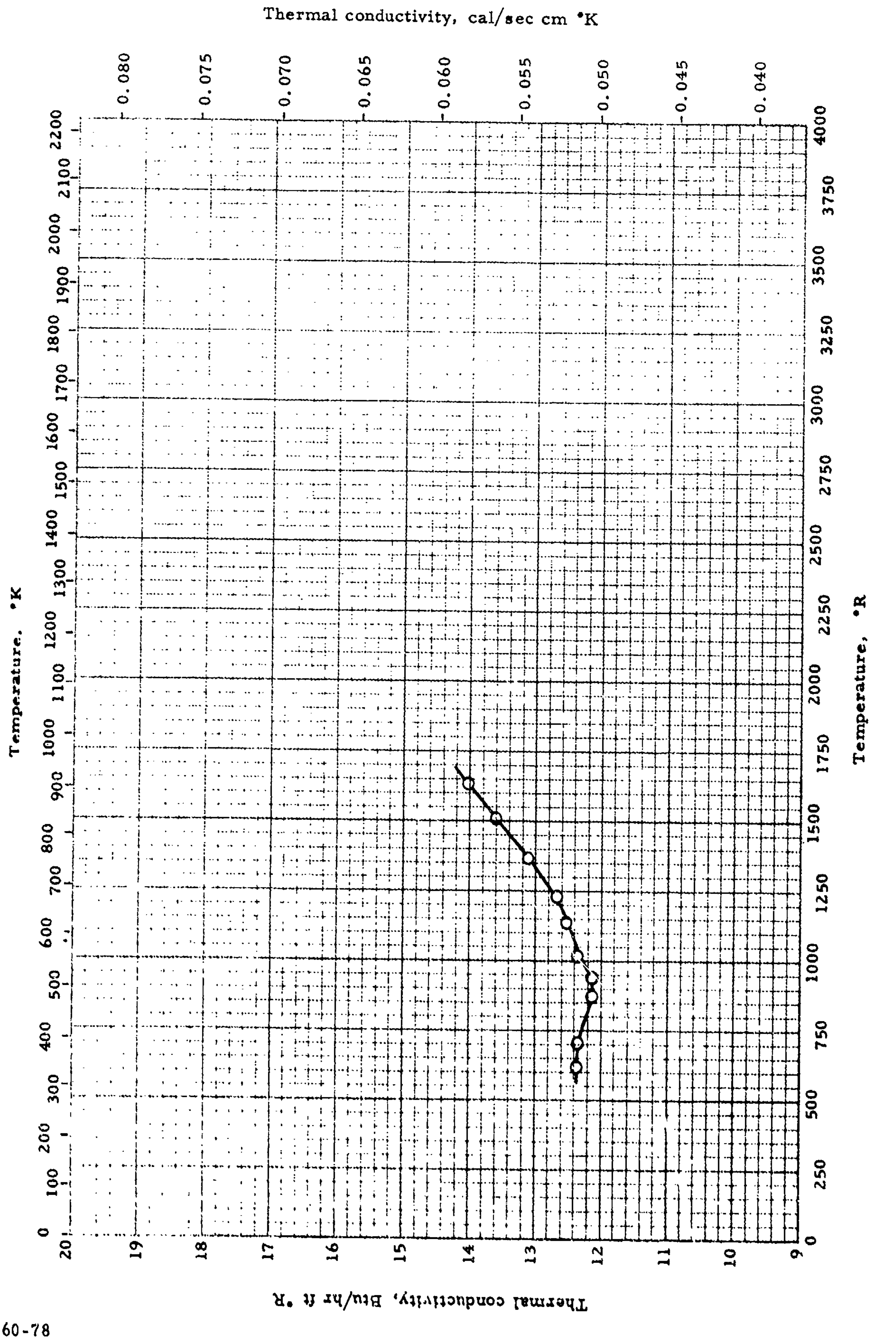


SPECIFIC HEAT -- ZIRCONIUM + NIOBIUM

SPECIFIC HEAT -- ZIRCONIUM + NIOBIUM

REFERENCE INFORMATION

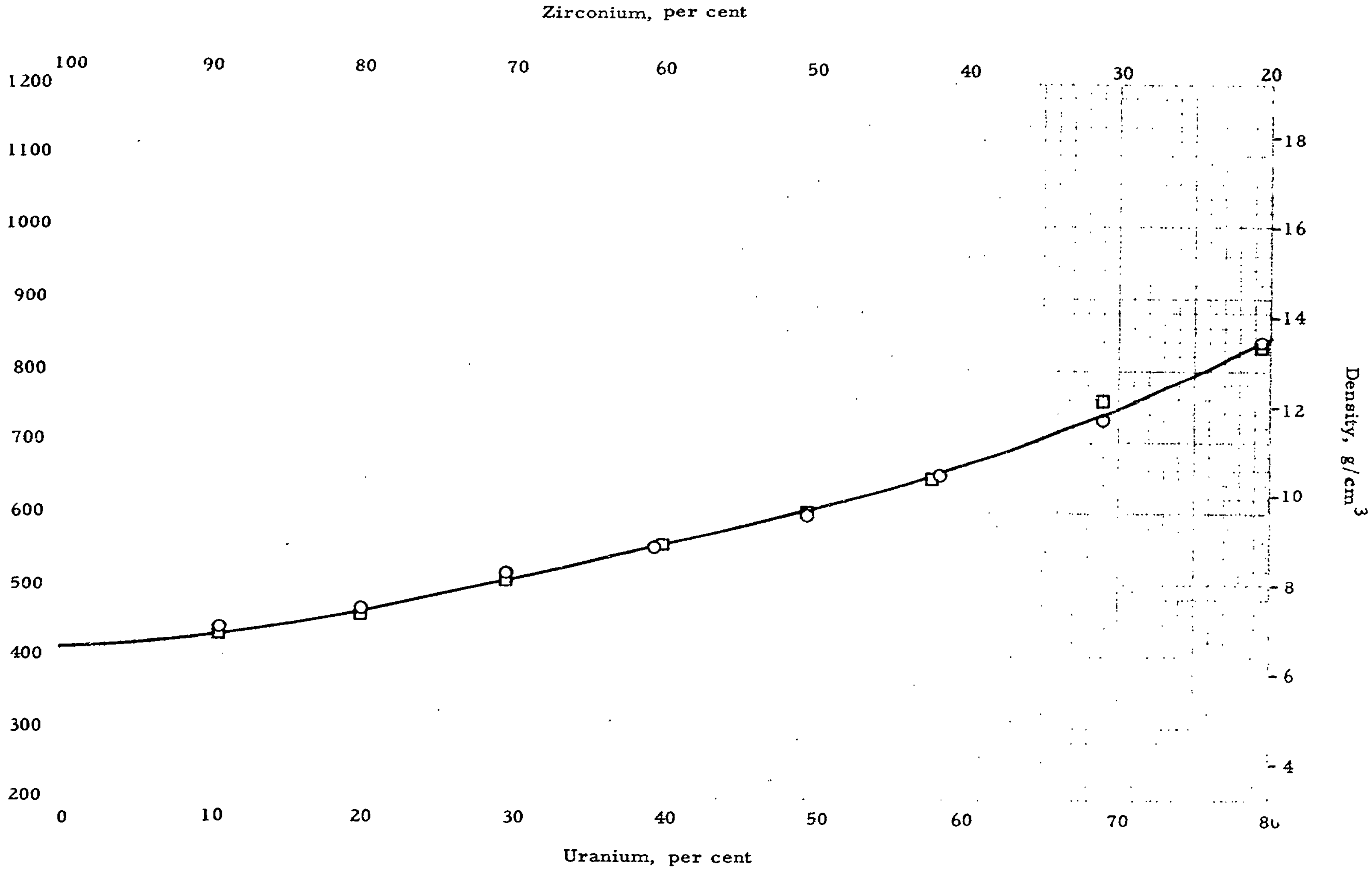
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Scott, J. L.	57-43	672-1932	82.5% Zr; 17.5% Nb; arc melted from iodide process Zr and Nb (Eutectoid composition)	Guarded sample	All samples homogenized 14 days at 1300°C in vacuum; tested in vacuum; 2 samples, 1st heating
□	Ibid.	57-43	672-1932	Same as above	Same as above	3rd sample, 1st heating
△	Ibid.	57-43	672-1932	Same as above	Same as above	3rd sample, 2nd heating
◇	Ibid.	57-43	672-1932	Same as above	Same as above	4th sample, annealed 2 wk. at 600°C
▽	Ibid.	57-43	672-1932	Same as above	Same as above	4th sample, 2nd heating



THERMAL CONDUCTIVITY -- ZIRCONIUM + NIOBIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E.	57-50	615-1670	1.52% Nb; 0.14% Hf; 0.08% C	Temp. distribution along resistance heated rod	Annealed 48 hr. at 600 °C in vacuum; water quenched

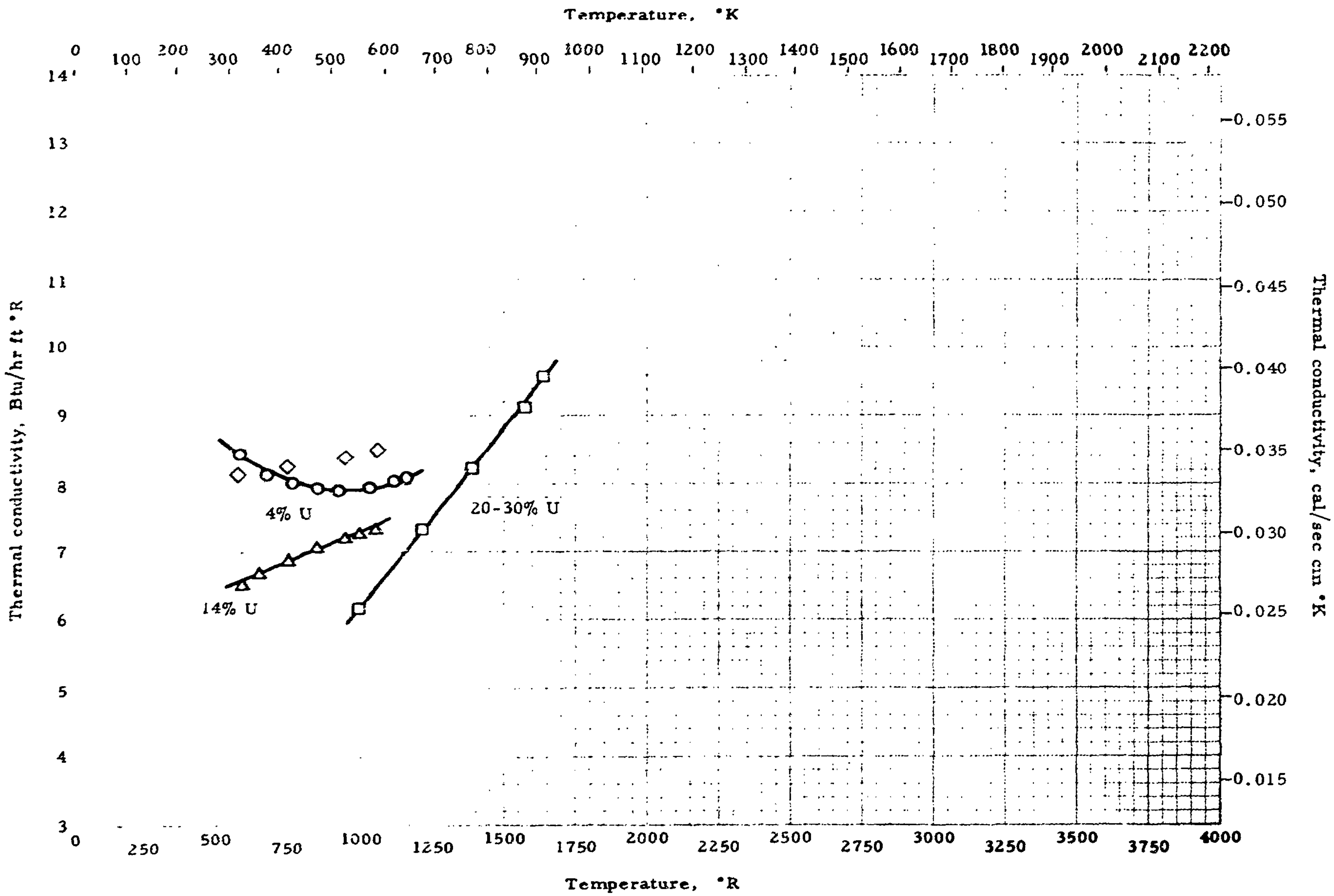


DENSITY -- ZIRCONIUM + URANIUM

DENSITY -- ZIRCONIUM + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H.A. and Rough, F.A.	53-109	Room	10 - 80% U	Not given	Heat treated 1 hour at 800°C; water quenched
□	Ibid.	53-109	Room	10 - 80% U	Same as above	Heat treated 24 hours at 575°C; furnace cooled

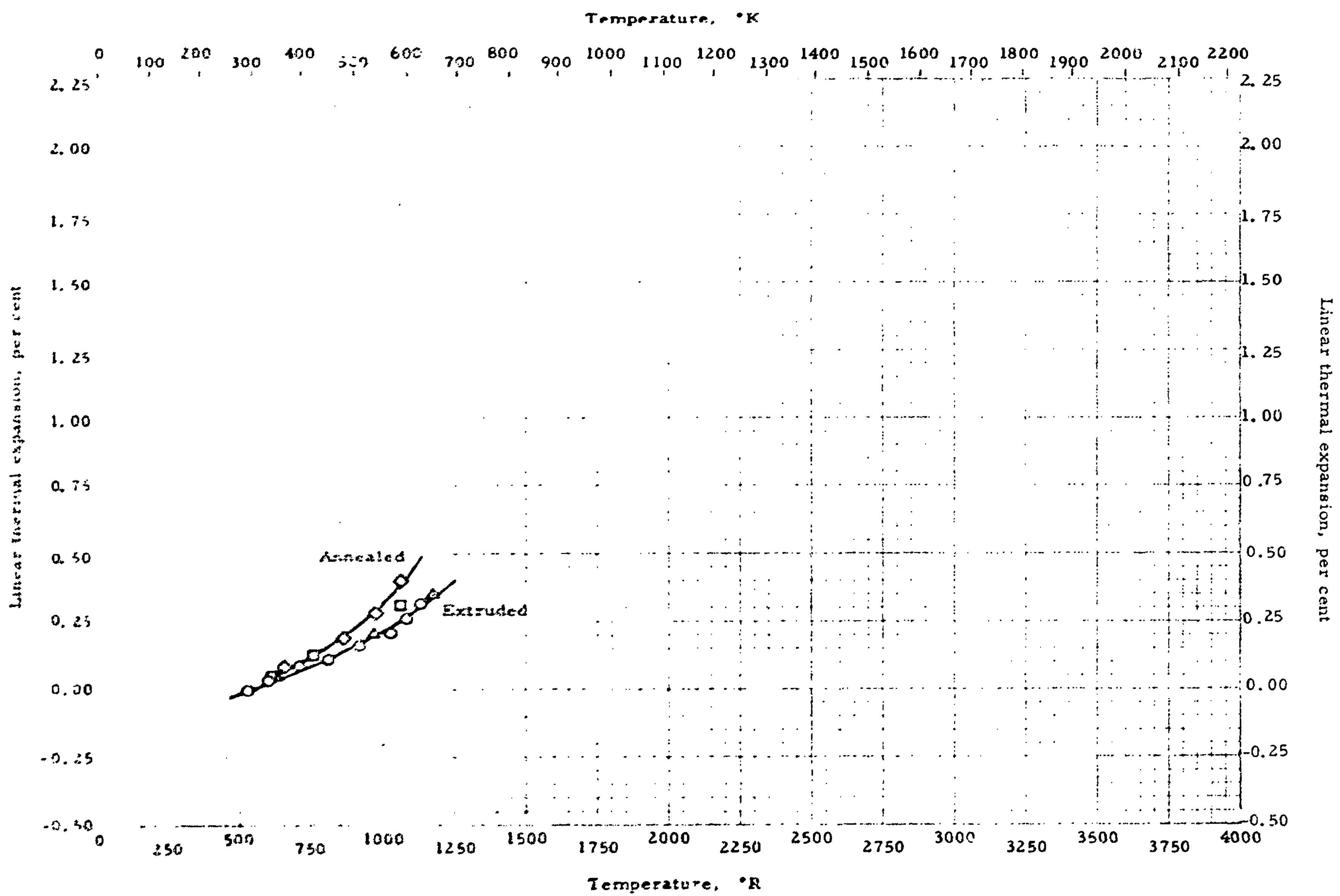


THERMAL CONDUCTIVITY -- ZIRCONIUM + URANIUM + X

THERMAL CONDUCTIVITY -- ZIRCONIUM + URANIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W.	53-46	582-1212	4.34% U; 1.33% Sn; 0.125% Fe; 0.09% Cr; 0.04% B; 0.027% Ni; 0.013% N_2	Comparative; rods (Armco Iron Standard)	In A atmos.
◇	Bing, G., Fink, F. W. and Thompson, H. B.	51-64	582-1032	97% Zr; 3% U	Comparative; rods	Auth. est. accuracy ± 3%
□	McCreight, L. R.	57-148	996-1640	Zr-U Alloys, 2 samples: a) 77% Zr; 20% U b) 70.3% Zr; 29.7% U	Two methods: comparative; rods and axial heat flow in rod with guarded sample	Same data for both samples. Sample a) vac. cast and Sample b) extruded powder with 98% theoretical density
△	Bing, G., Fink, F. W. and Thompson, H. B.	51-64	582-1032	86% Zr; 14% U	Comparative; rods	Auth. est. accuracy ± 3%

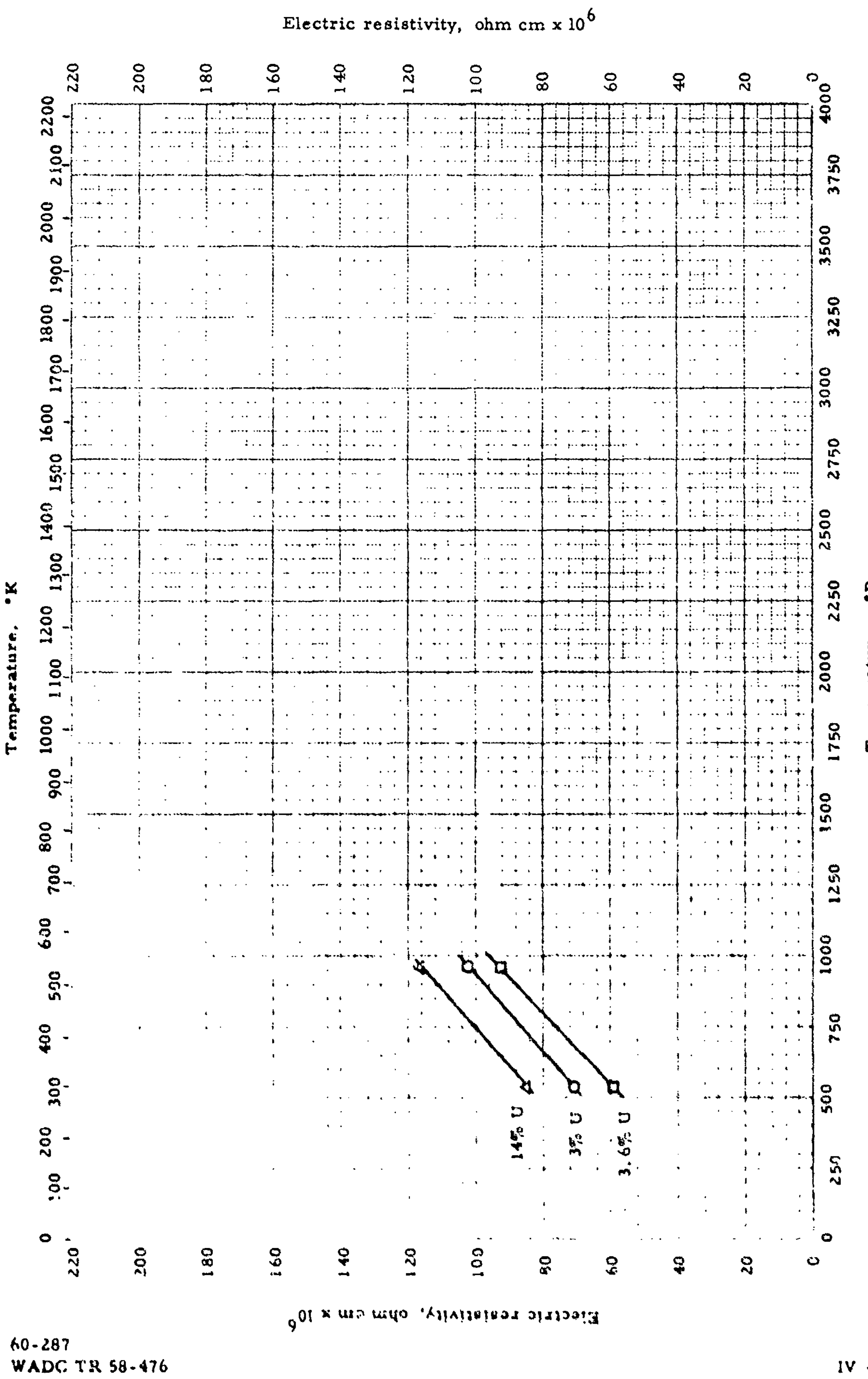


LINEAR THERMAL EXPANSION -- ZIRCONIUM + URANIUM

LINEAP THERMAL EXPANSION -- ZIRCONIUM + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	McCreight, L. R.	52-119	600-1140	69% Zr; 31.06% U	Gaertner interferometer in Argon atmosphere	Prepared from hydrides, decomposed and sintered, extruded at 1000°C, measured parallel to extrusion, first run after extrusion
□	Ibid.	52-119	540-1059	Same as above	Same as above	Same as above, second run
△	Ibid.	52-119	600-1176	Same as above	Same as above	Same as above, third run after annealing 2 hr. at 450°C
◇	Ibid.	52-119	540-1059	Same as above	Same as above	Same as above, fourth run after annealing 2 hr. at 900°C



ELECTRIC RESISTIVITY -- ZIRCONIUM + URANIUM

ELECTRIC RESISTIVITY -- ZIRCONIUM + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bing, G., Fink, F. W. and Thompson, H. B.	51-64	537-960	3% U	Potential drop	Auth. est. accuracy ± 1%
□	Ibid.	51-64	537-960	3.61% U; 0.05% C; 0.007% N	Same as above	Low hafnium crystal bar. Double arc melted, forged at 1250°F, rolled at 1250°F annealed at 1450°F. Auth. est. accuracy ± 1%
△	Ibid.	51-64	537-960	14% U	Same as above	Auth. est. accuracy ± 1%

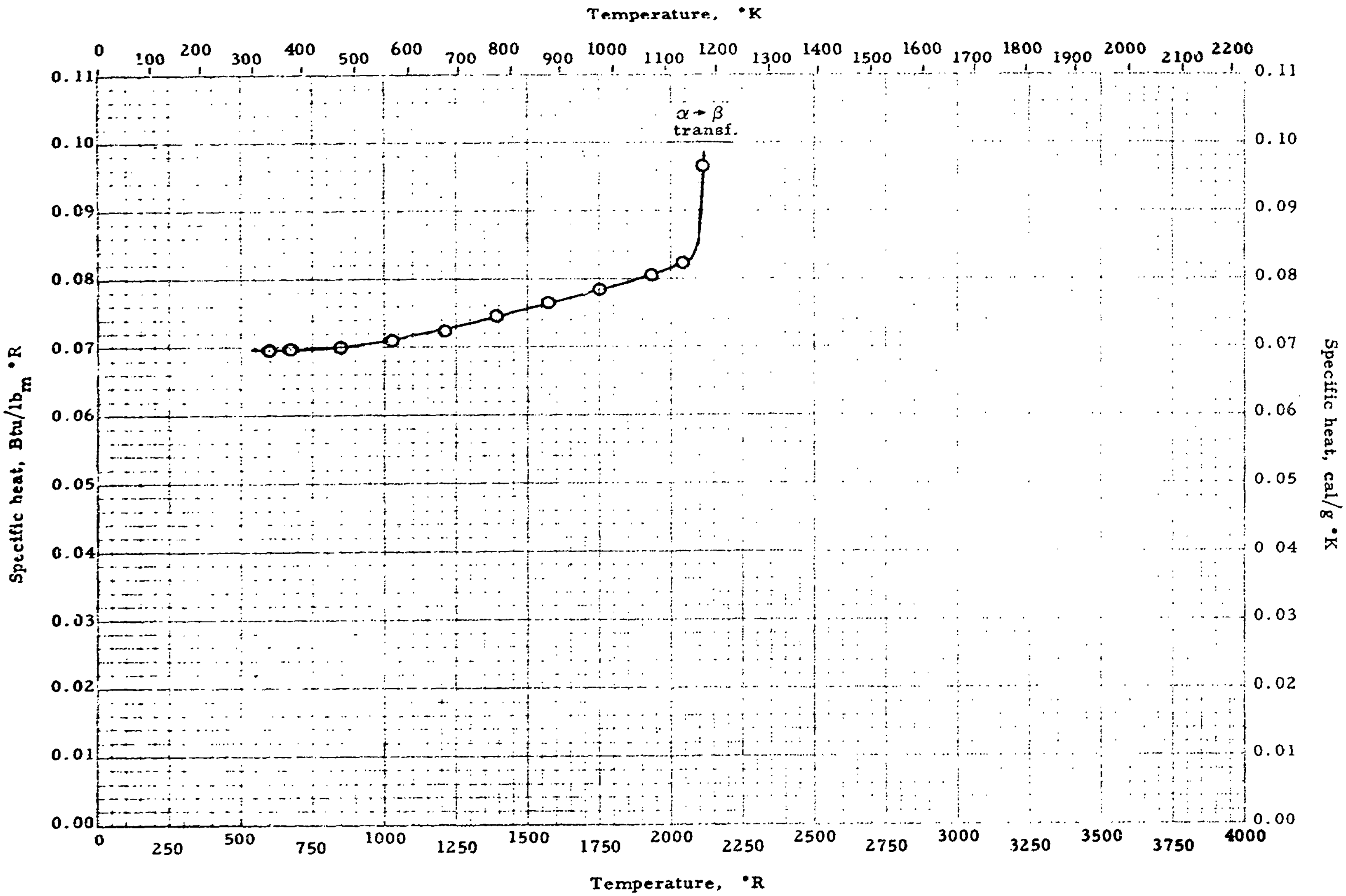
Symbol	Material Analysis, %			Density	
	B	Fe	Sn	lb_m/ft^3	g/cm^3
O	0.44			406.13	6.5055
	0.78			405.41	6.4940
	1.21			404.51	6.4796
	1.77			402.59	6.4489
		0.18		408.99	6.5514
			1.36	404.46	6.4789
			1.40	408.27	6.5399
			1.46	405.03	6.4880
			1.54	406.81	6.5164
			1.58	405.66	6.4789

DENSITY -- ZIRCONIUM + X

DENSITY -- ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Beard, A. P., Harrison, J. W. and Clark, W. B.	57-76	Room	Three binary systems: a - 0.44 to 1.77% B b - 0.18% Fe c - 1.36 to 1.58% Sn	ρ: weight and volume by CCl_4 displacement	Alloys made by 2 consumable electrode melts in sequence in arc furnace with He atmos., extruded repeatedly. Density data reported are avg. of 2-4 tests each

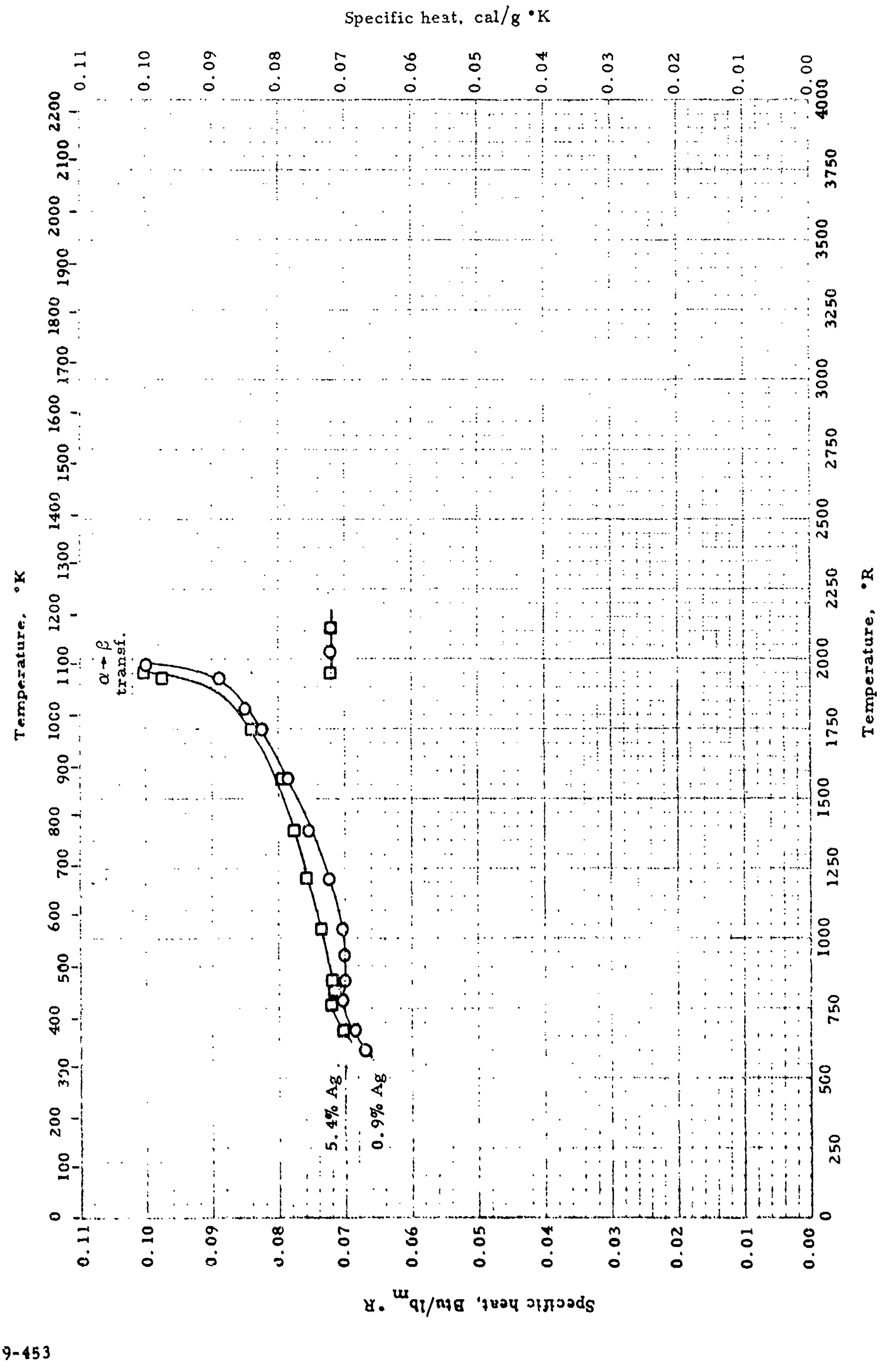


SPECIFIC HEAT -- ZIRCONIUM + INDIUM + X

SPECIFIC HEAT -- ZIRCONIUM + INDIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Scott, J. L.	57-43	600-2112	92.23% Zr; 7.77% In; 0.021% Fe; 0.016% O; 0.0067% C; 0.003% N; 0.00051% H; arc melted	Guarded sample	Homogenized 14 days at 1300°C in vacuum

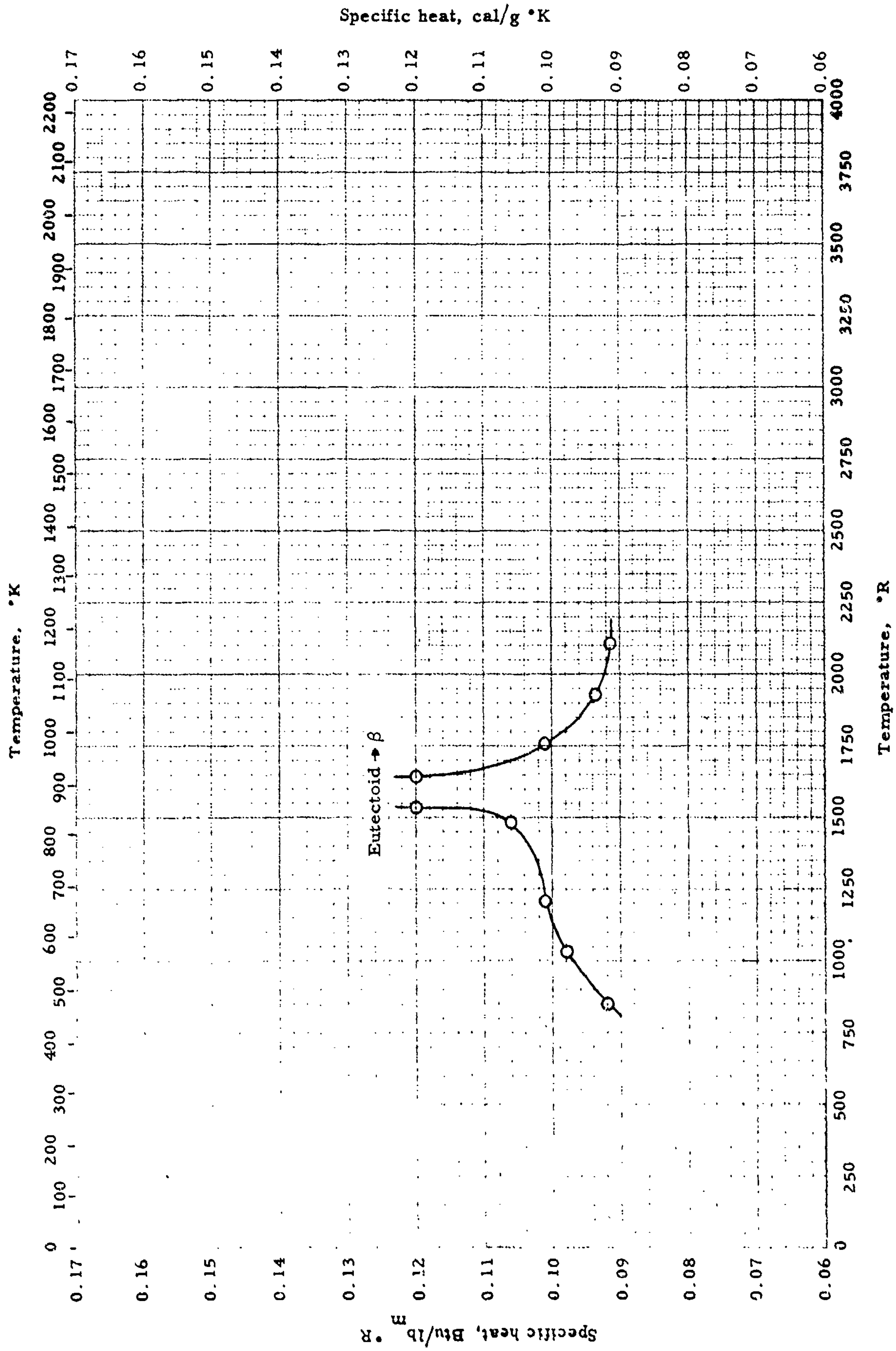


SPECIFIC HEAT -- ZIRCONIUM + SILVER + X

SPECIFIC HEAT -- ZIRCONIUM + SILVER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Scott, J. L.	57-43	600-2112	Arc melted; 0.887% Ag; 0.036% Fe; 0.015% O_2; 0.014% C; 0.004% Cu; 0.0008% N_2; 0.00044% H_2	Guarded sample	Homogenized 14 days at 1300°C in vacuum. Tested under vacuum (0.01μ Hg)
□	Ibid.	57-43	672-1932	Arc melted; 5.37% Ag; 0.028% Fe; 0.022% O_2; 0.013% C; 0.002% Cu; 0.0011% H_2; 0.00049% N_2	Same as above	Same as above

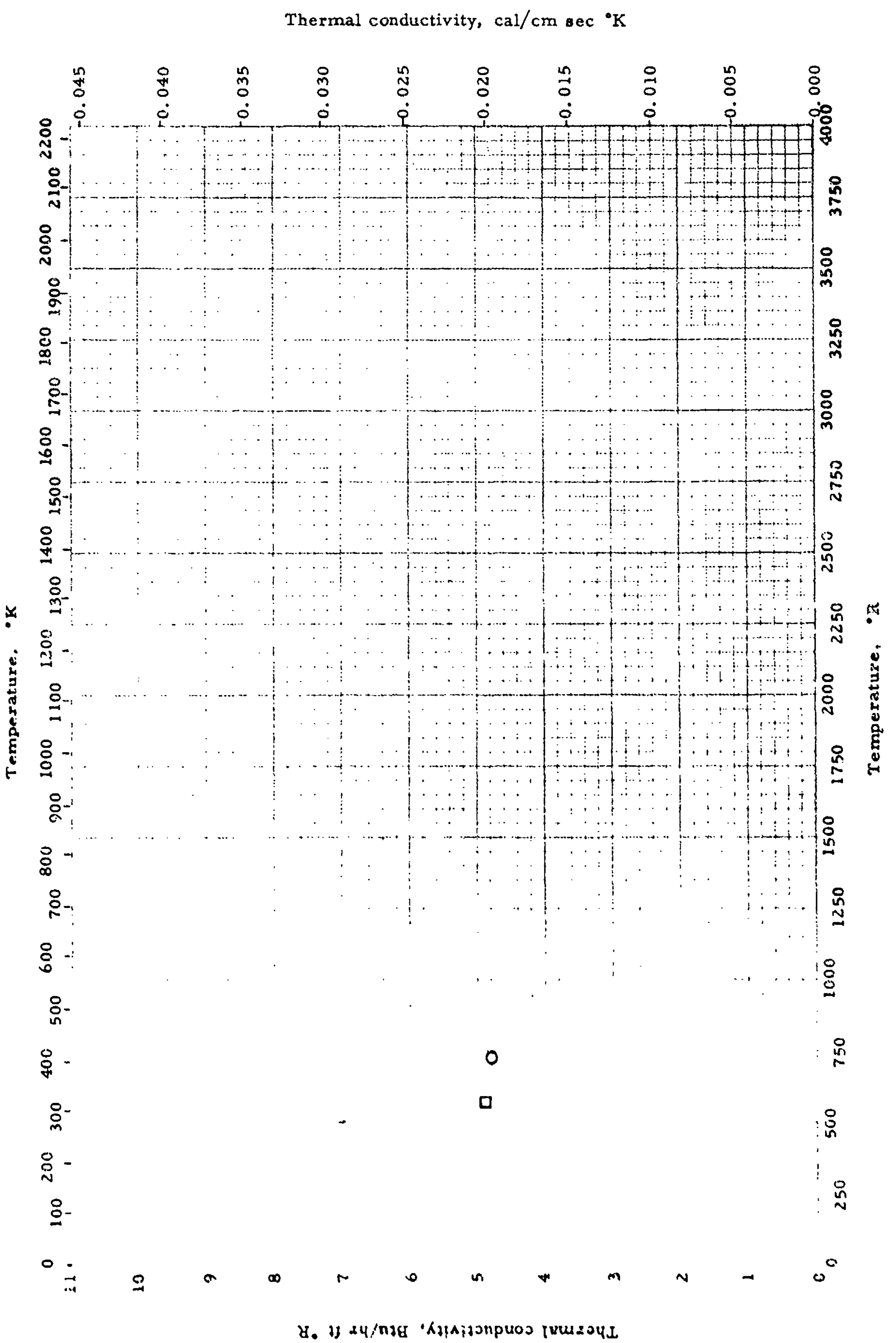


SPECIFIC HEAT -- ZIRCONIUM + TITANIUM

SPECIFIC HEAT -- ZIRCONIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Scott, J. L.	57-43	852-2112	65.6% Zr; 34.4% Ti; arc melted from iodide process Zr and iodide process Ti (Eutectoid composition)	Guarded sample	Homogenized 14 days at 1300°C in vacuum

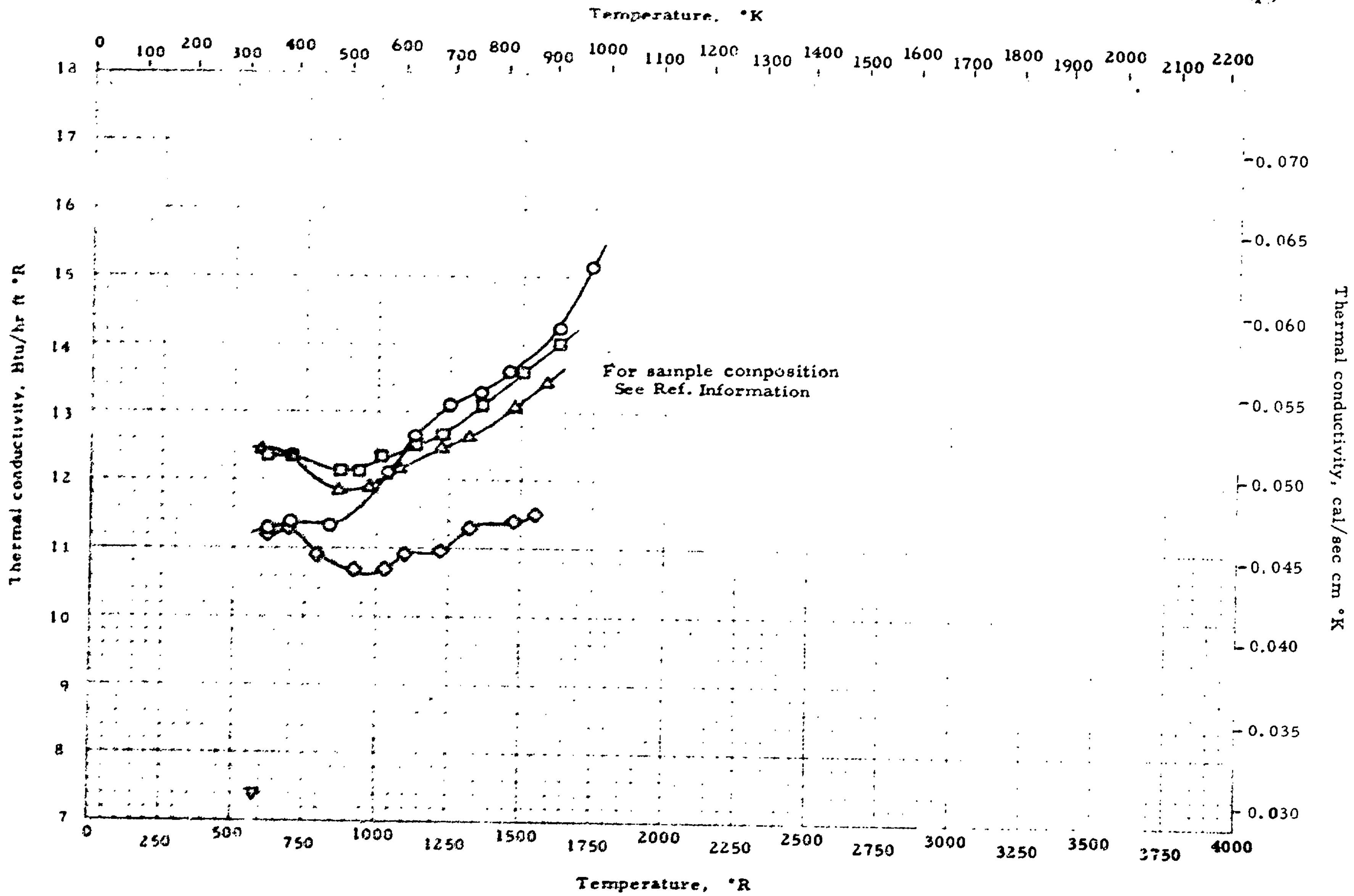


THERMAL CONDUCTIVITY -- ZIRCONIUM + ALUMINUM

THERMAL CONDUCTIVITY -- ZIRCONIUM + ALUMINUM

REFERENCE INFORMATION

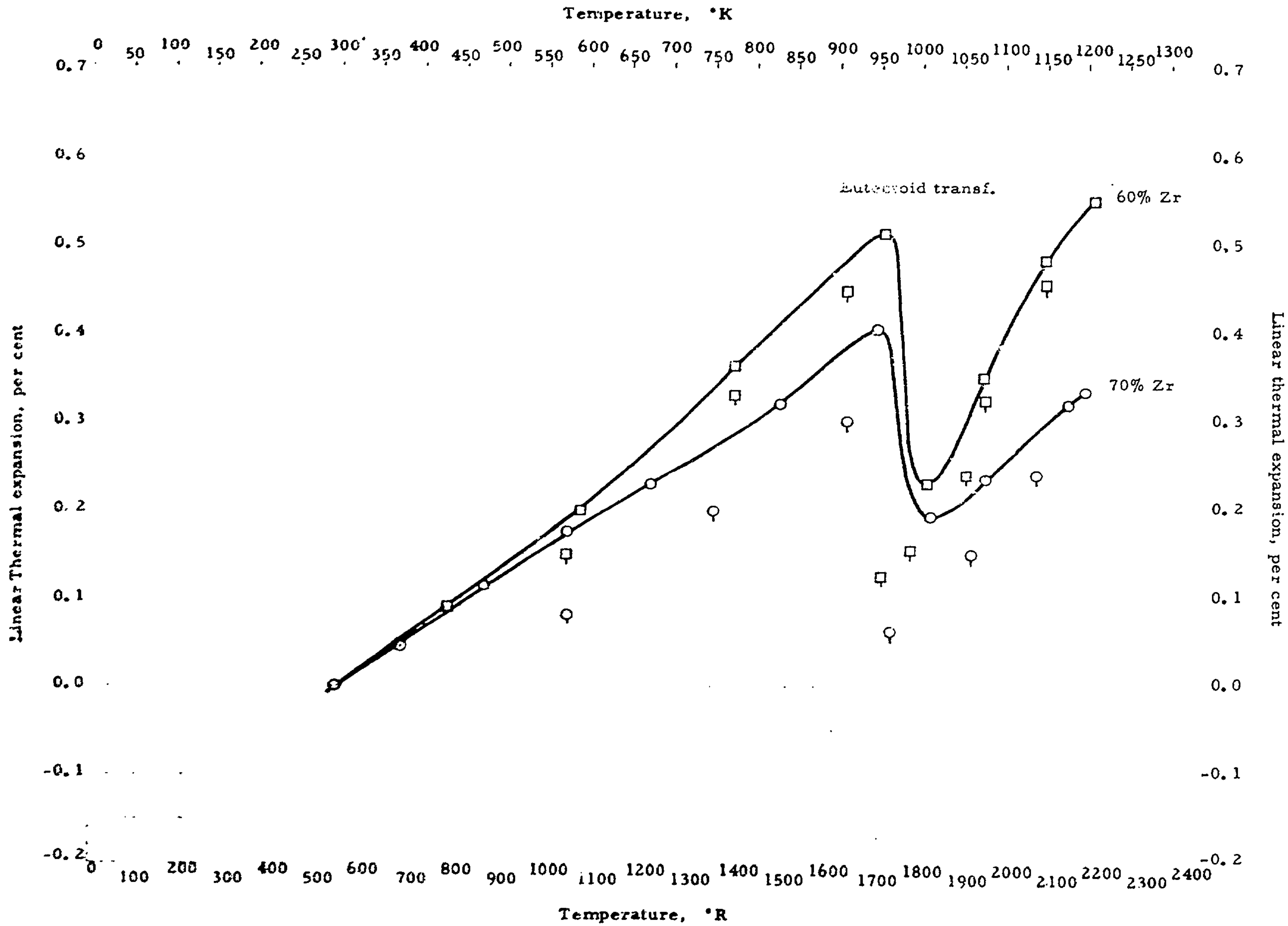
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Smith, K.F. and Chiswik, H.H.	56-113	671-733	3% Al	Comparison type apparatus heated by NaK baths	
□	Argonne Natl. Laboratory	54-115	574	4% Al	Not given	



THERMAL CONDUCTIVITY -- ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °K	Material Composition	Test Method	Remarks
○	Mikryukov, V. E.	57-50	618-1750	0.98% Ta; 0.97% Hf; 0.3% C	Temp. distribution along resistance heated rod	Annealed 48 hr. at 600 °C in vacuum; water quenched
□	Ibid.	57-50	615-1670	1.52% Nb; 0.14% Hf; 0.08% C	Same as above	Same as above
△	Ibid.	57-50	598-1585	0.14% Hf; 0.08% C	Same as above	Same as above
◇	Ibid.	57-50	610-1555	0.97% Hf; 0.3% C	Same as above	Same as above
▽	Argonne Natl. Laboratory	54-115	575	7% Ti	Not given	

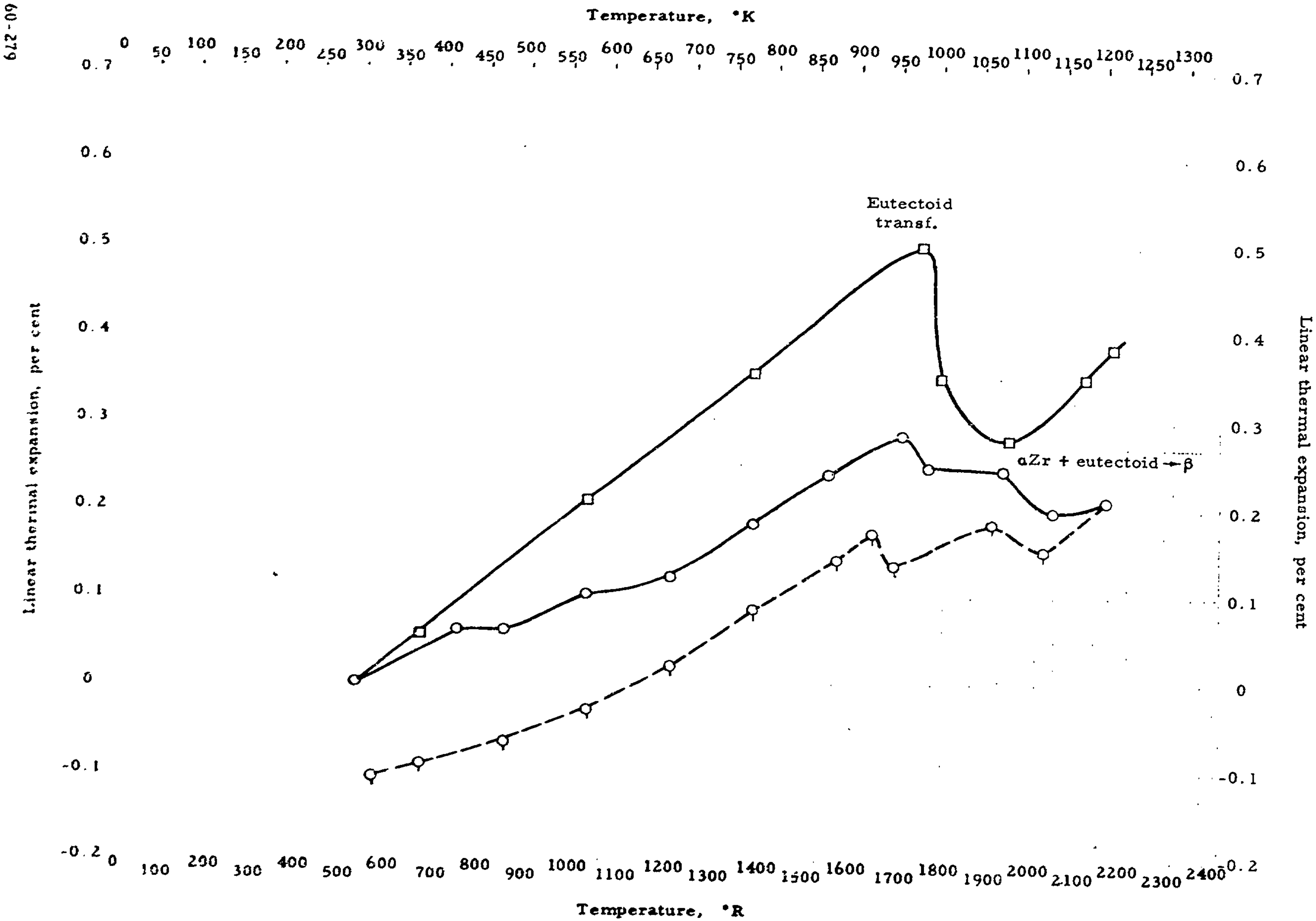


LINEAR THERMAL EXPANSION -- ZIRCONIUM + THORIUM
(60 - 70% Zr)

LINEAR THERMAL EXPANSION -- ZIRCONIUM + THORIUM
(60 - 70% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Danielson, G. C. et al.	52-117	528-2148	70% Zr; 30% Th	Quartz tube dilatometer with strain gauge; temp. by thermocouple. Automatic plotting	○ - heating ⚲ - cooling
□	Ibid.	52-117	528-2166	60% Zr; 40% Th	Same as above	□ - heating □ - cooling

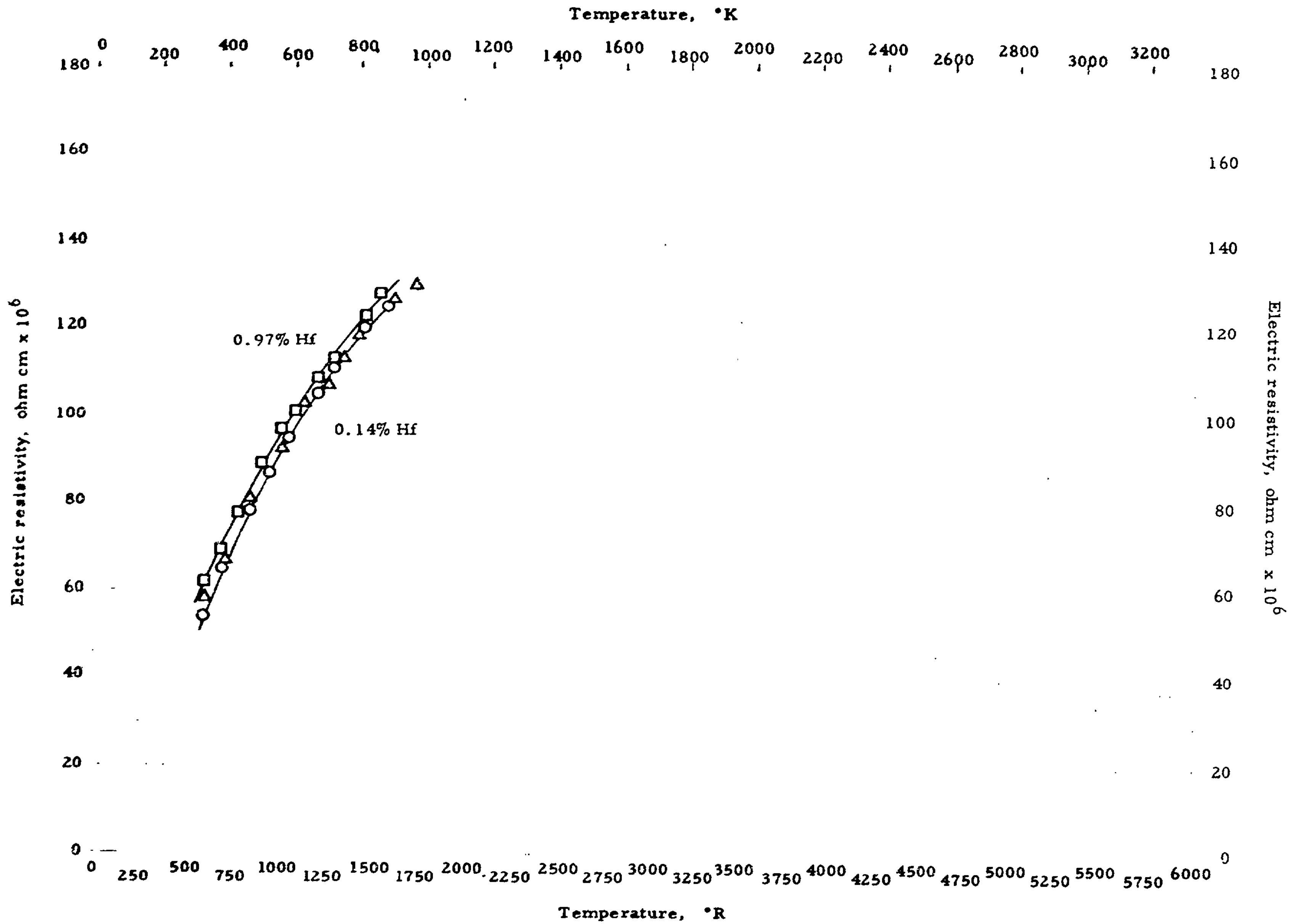


LINEAR THERMAL EXPANSION -- ZIRCONIUM + THORIUM
(80 - 90% Zr)

LINEAR THERMAL EXPANSION -- ZIRCONIUM + THORIUM
(80 - 90% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Danielson, G. C. et al.	52-117	528-2157	90% Zr; 10% Th	Quartz tube dilatometer with strain gage pickup. Temp. measured by thermocouple. Automatic plotting	○ - heating ♀ - cooling
□	Ibid.	52-117	528-2166	80% Zr; 20% Th	Same as above	

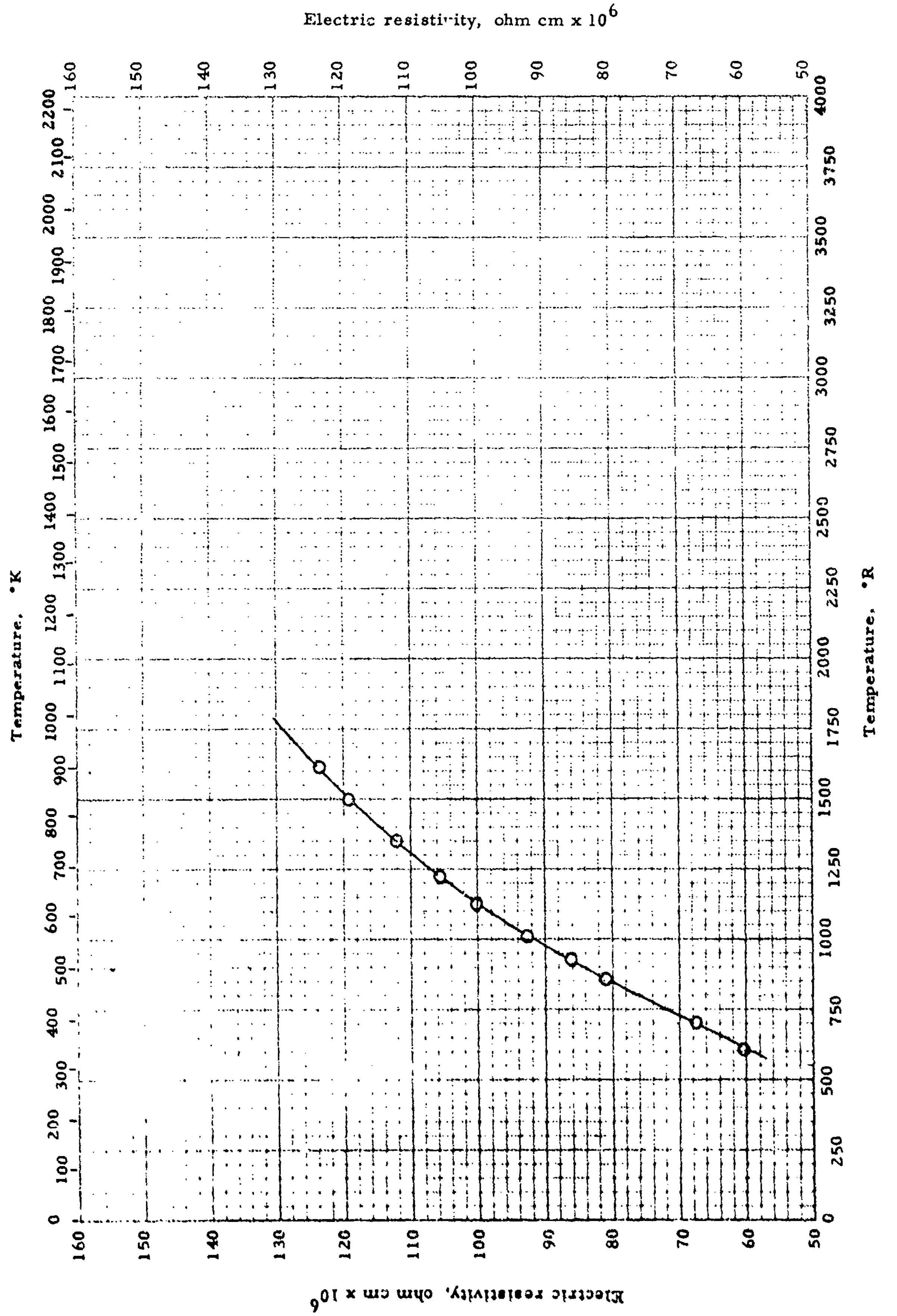


ELECTRIC RESISTIVITY -- ZIRCONIUM + HAFNIUM + X

ELECTRIC RESISTIVITY -- ZIRCONIUM + HAFNIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mikryukov, V. E.	57-50	595-1585	0.14% Hf; 0.08% C	Potential drop	Annealed 2 hr. at 700°C, water quenched
□	Ibid.	57-50	610-1555	0.97% Hf; 0.3% C	Same as above	Same as above
△	Ibid.	57-50	615-1747	0.97% Hf; 0.03% C; 0.98% Ta	Same as above	Annealed 48 hr. at 600°C, water quenched

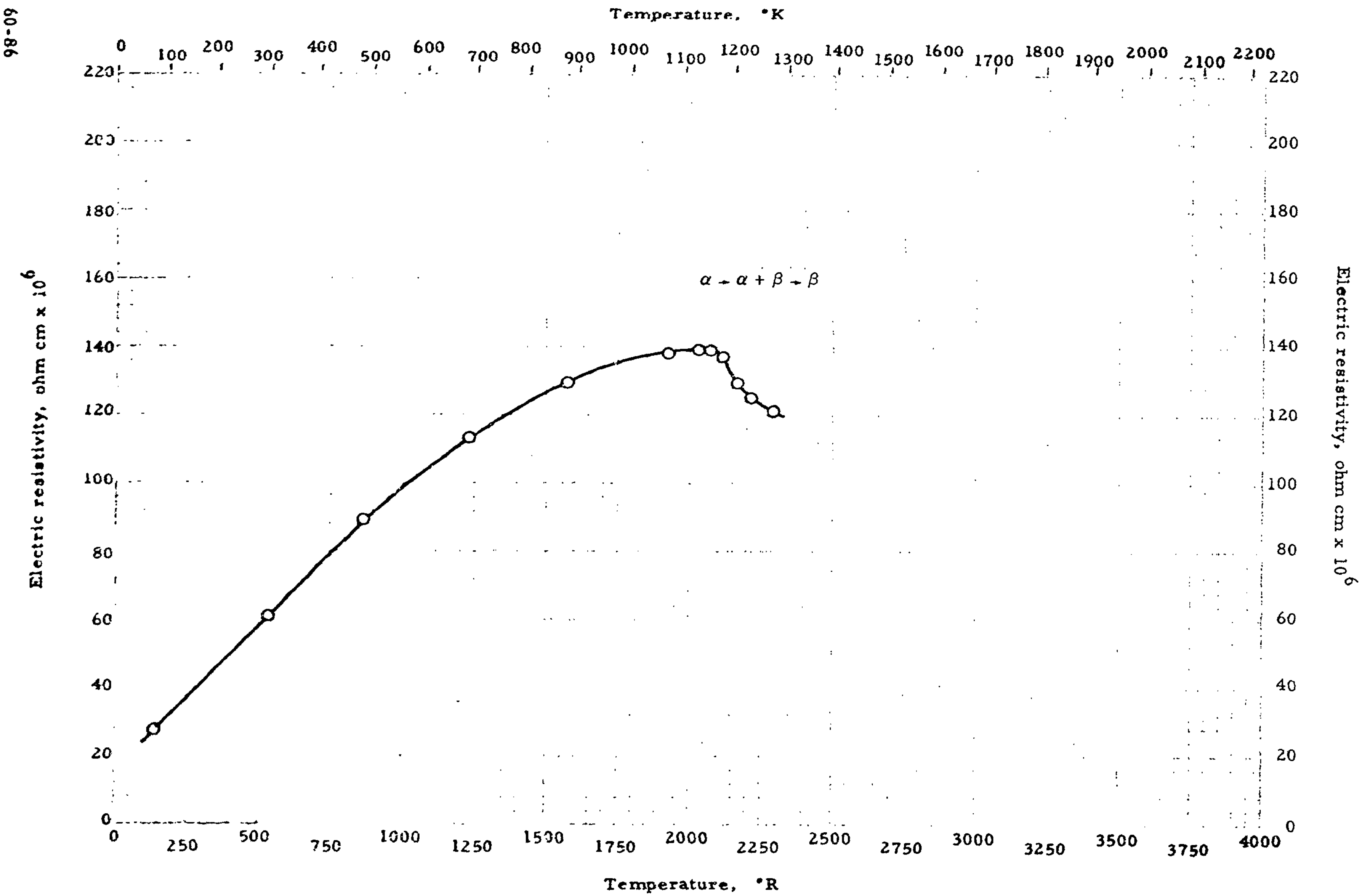


ELECTRIC RESISTIVITY -- ZIRCONIUM + NIOBIUM + X

ELECTRIC RESISTIVITY -- ZIRCONIUM + NIOBIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mikryukov, V.E.	57-50	615-1620	1.52% Nb; 0.14% Hf; 0.08% C	Potential drop	Annealed 48 hr. at 600°C in vacuum, water quenched

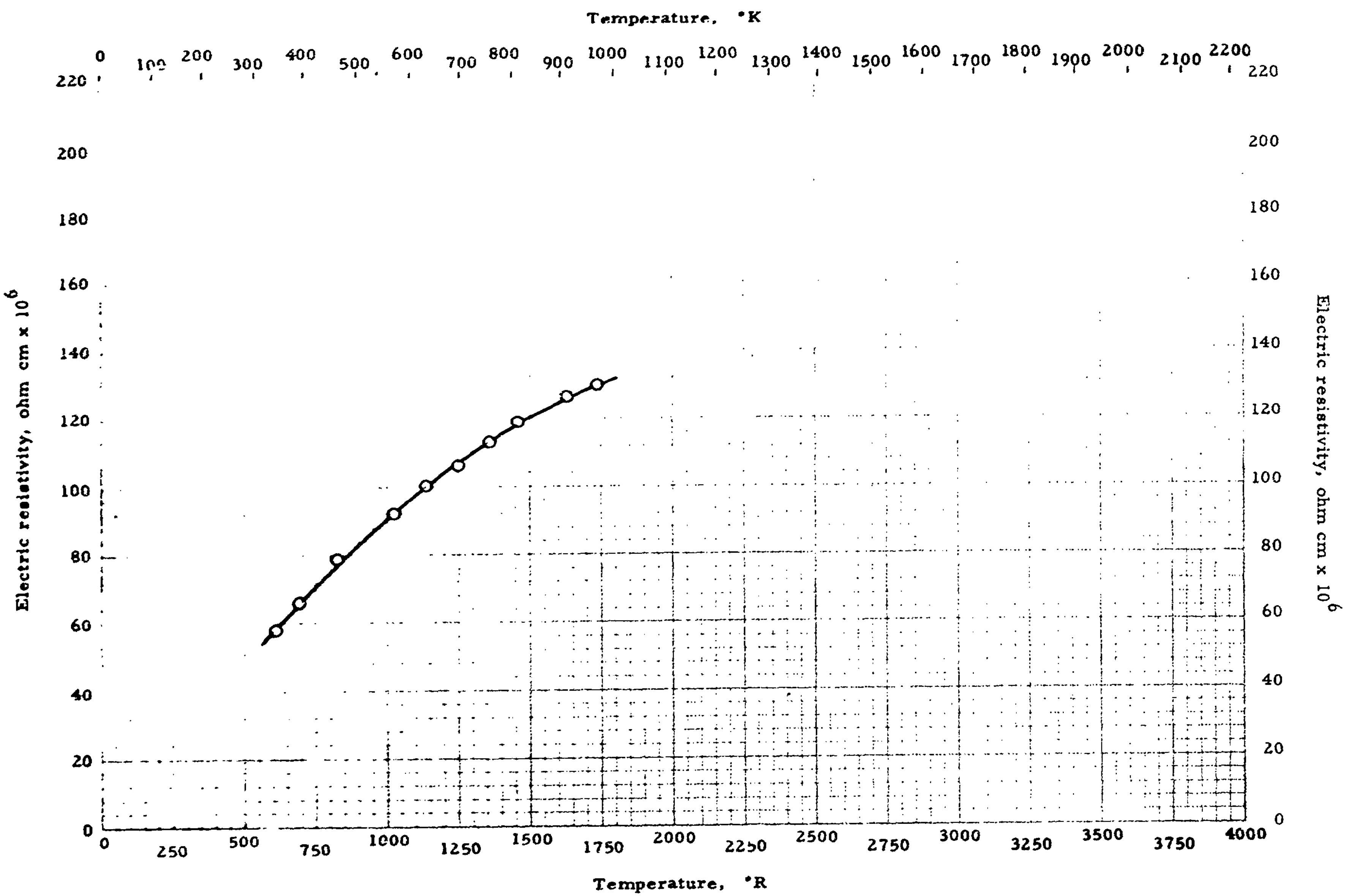


ELECTRIC RESISTIVITY -- ZIRCONIUM + OXYGEN + X

ELECTRIC RESISTIVITY -- ZIRCONIUM + OXYGEN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bostrom, W.A.	57-100	132-2292	0.33% O_2 ; 0.051% Fe; 0.03% Hf; 0.02% ea. Al, Ca, C; 0.01% W	Kelvin double bridge	

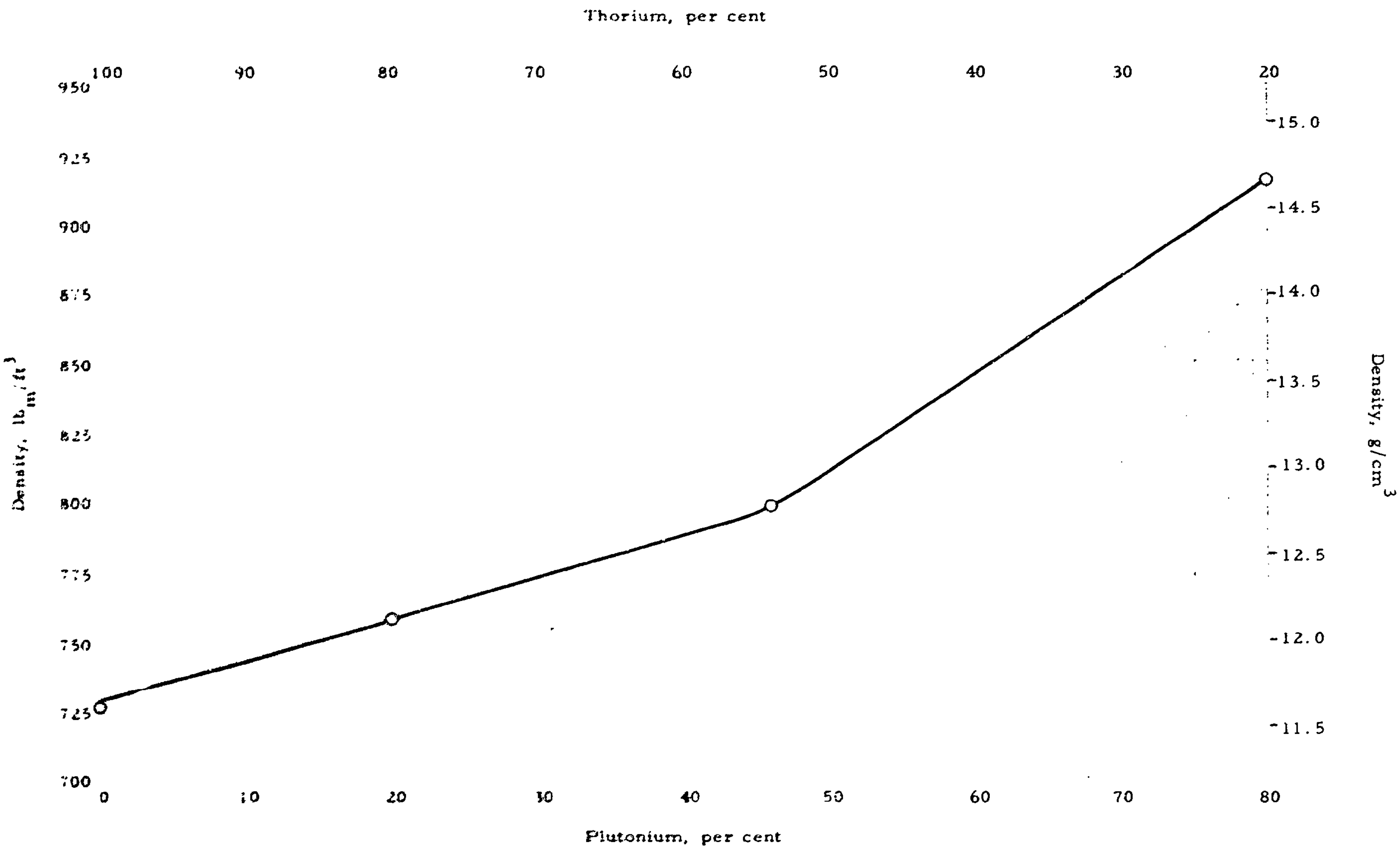


ELECTRIC RESISTIVITY -- ZIRCONIUM + TANTALUM + X

ELECTRIC RESISTIVITY -- ZIRCONIUM + TANTALUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mikryukov, V.E.	57-50	615-1747	0.98% Ta; 0.97% Hf; 0.03% C	Potential drop	Annealed 48 hr. at 600 °C in vacuum, water quenched



DENSITY -- THORIUM + PLUTONIUM

DENSITY -- THORIUM + PLUTONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Poole, D. M., Williamson, G. K. and Marples, J. A. C.	57-75	540	Alloy series: 0 - 80% Pu	ρ: weight in air, in water, and in ethylene bromide	

PROPERTIES OF THORIUM + URANIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 50% Th . .	2710 °R	1510 °K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	○	2714	1508
	□	2659	1477
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF THORIUM + URANIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Carlson, O.N.	50-41	2714	49.8% Th; 28.6% U; 21.4% Zr	MP: observation of first liquid drop, optical pyrometer sighting on black body cavity	
□	Ibid.	50-41	2659	33.3% Th; 33.3% U; 33.3% Zr	MP: same as above	

PROPERTIES OF THORIUM + ZIRCONIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 60% Th. . .	2760°R	1530°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

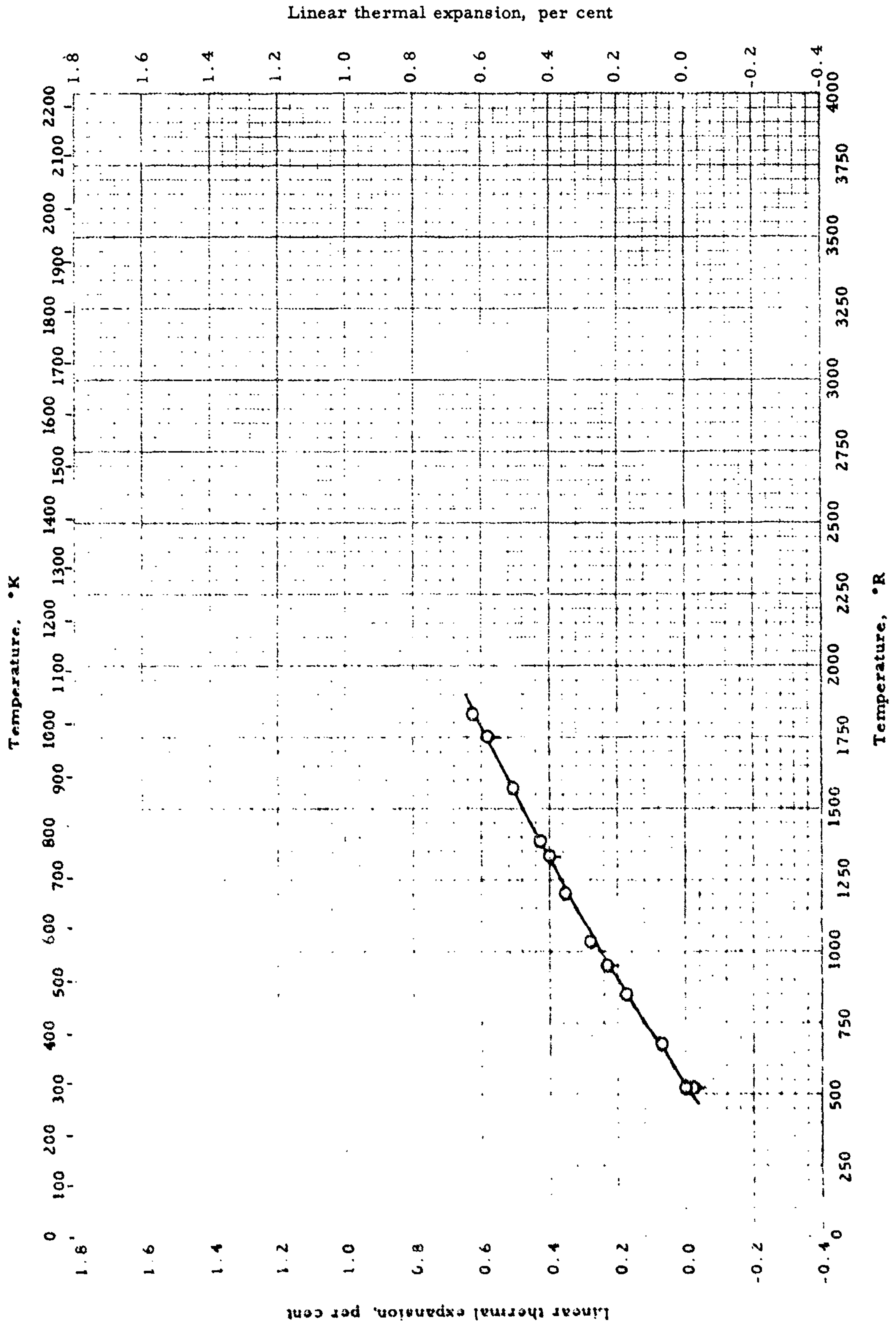
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	○	2759	1533
	□	2754	1530
	△	2659	1477
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF THORIUM + ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Carlson, O.N.	50-41	2570-2759	61.4% Th; 27.6% Zr; 11.0% U	MP: observation of first liquid drop, optical pyrometer sighting on black body cavity	
□	Ibid.	50-41	2570-2759	58.1% Th; 25.0% Zr; 16.9% U	MP: same as above	
△	Ibid.	50-41	2570-2759	33.3% Th; 33.3% Zr; 33.3% U	MP: same as above	

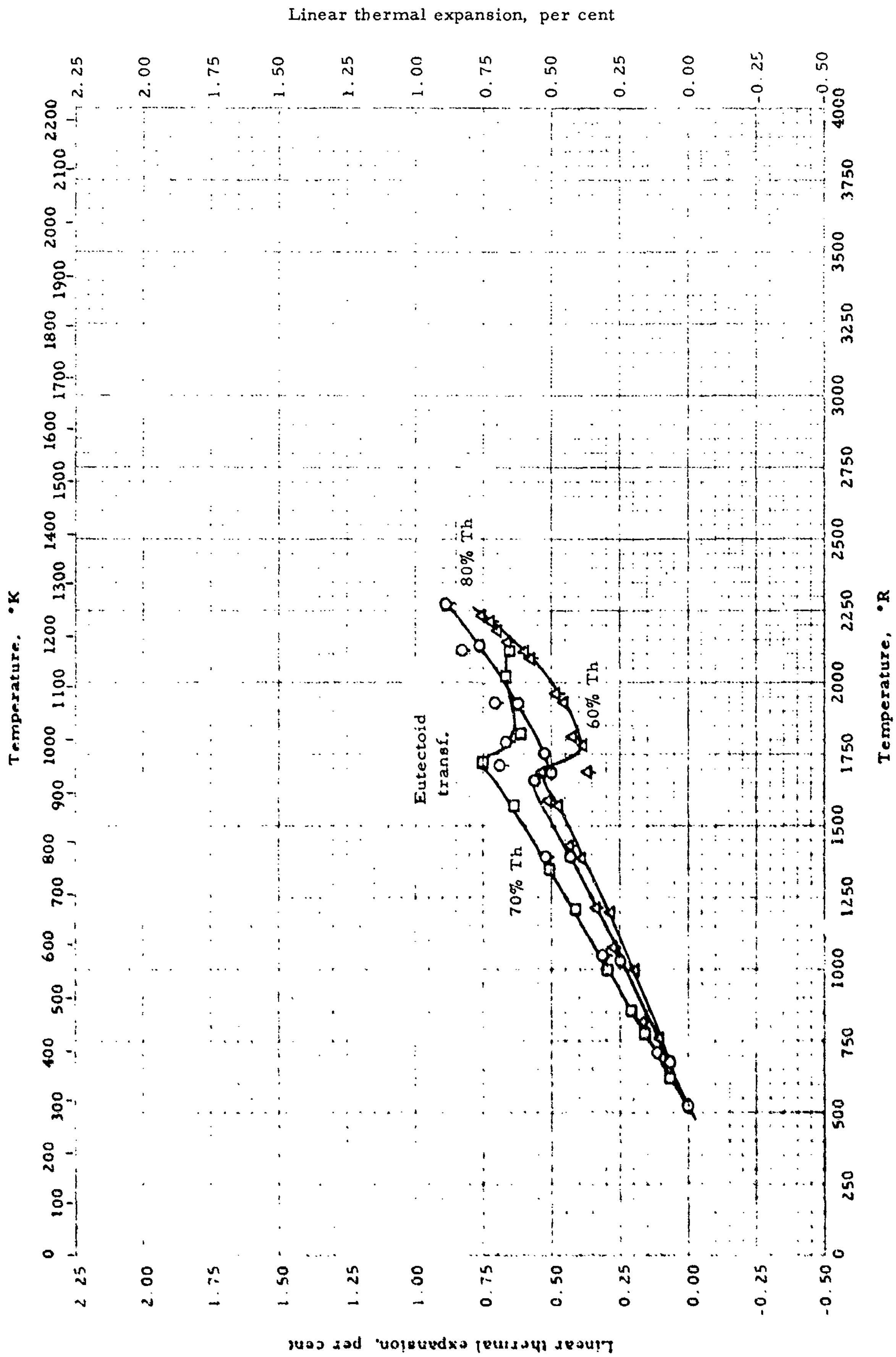


LINEAR THERMAL EXPANSION -- THORIUM + TITANIUM

LINEAR THERMAL EXPANSION -- THORIUM + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Danielson, G. C., et al.	52-117	528-1824	80% Th; 20% Ti	Quartz tube dilatometer, with strain gauge pickup to automatic plotter. Temp. measured by thermocouple	O - heating ♀ - cooling

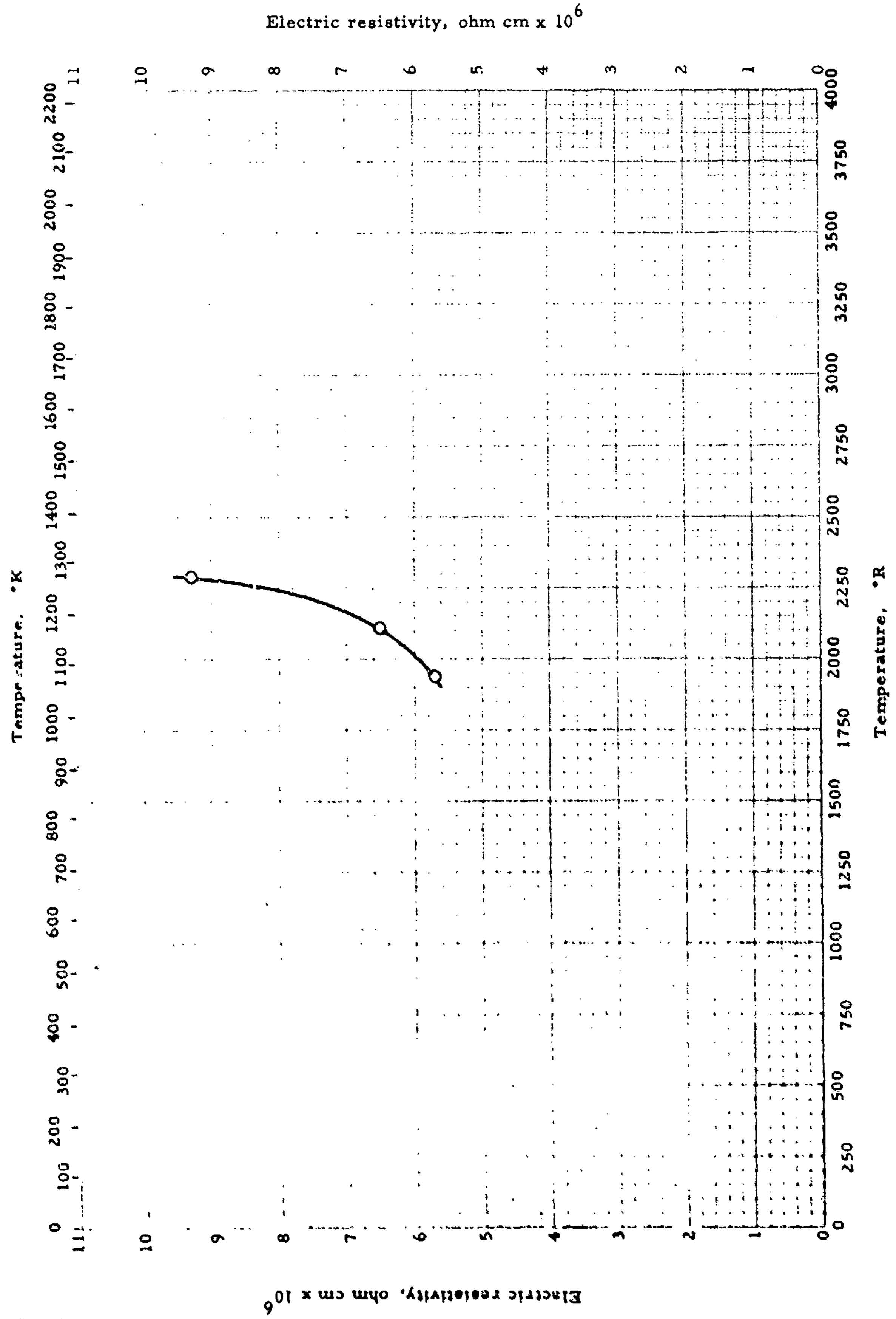


LINEAR THERMAL EXPANSION -- THORIUM + ZIRCONIUM

LINEAR THERMAL EXPANSION -- THORIUM + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Danielson, G. C. et al.	52-117	528-2274	80% Th; 20% Zr	Quartz tube dilatometer with strain gauges, temp. by thermocouple, automatic plotting	○ - heating ọ - cooling
□	Ibid.	52-117	528-2112	70% Th; 30% Zr	Same as above	
△	Ibid.	52-117	528-2247	60% Th; 40% Zr	Same as above	△ - heating △̣ - cooling



ELECTRIC RESISTIVITY -- THORIUM + URANIUM

ELECTRIC RESISTIVITY -- THORIUM + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bauer, A. A., Rough, F. A. and Dickerson, R. F.	57-158	1932-2292	2 - 10% U	Potential drop	Arc melted 5 - 7 times in He atmos., cast, cold swaged, annealed, water quenched. Auth. est. accuracy ± 2%

PROPERTIES OF ALUMINUM + COPPER + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	170 lb_m/ft^3 *	2.8 g/cm^3 *
Melting Point	1460°R *	810°K *
Heat of Fusion	167 Btu/lb_m *	93 g/cm^3 *
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Value for alloy with 3% Cu, 1.5% Fe; for others see Reported Values below.

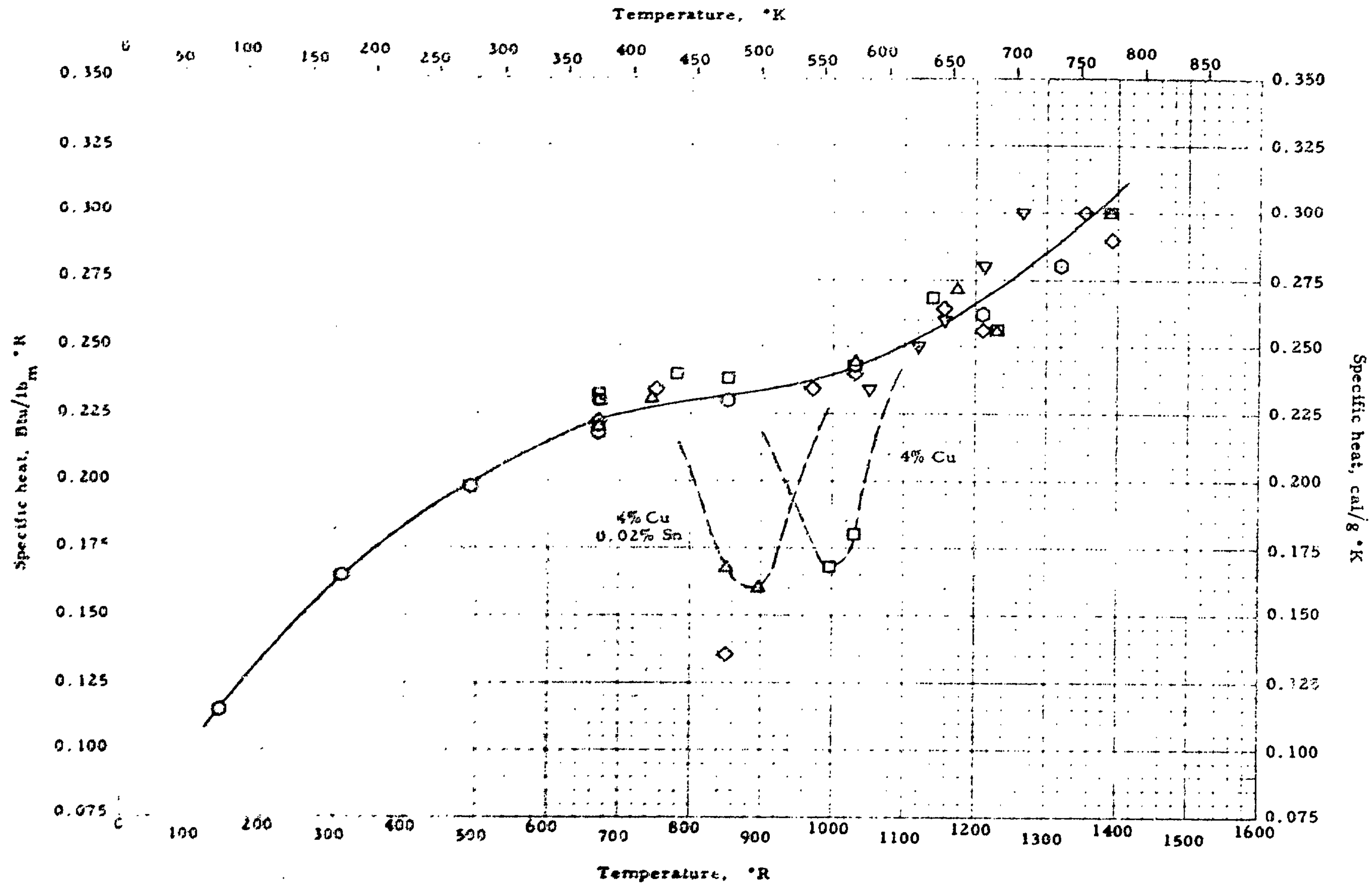
REPORTED VALUES

<u>Density:</u>		lb_m/ft^3	g/cm^3
	○	173.5	2.779
	□	184	2.94
	△	170	2.8
	◇	170	2.8
	◺	174	2.78
<u>Melting Point:</u>		°R	°K
	□	1430	794
	△	1459	810
	◇	1459	810
	▽	1414 ± 7	785 ± 4
<u>Heat of Fusion:</u>		Btu/lb_m	cal/g
	□	167	93
	◇	167	93
<u>Heat of Vaporization:</u>		Btu/lb_m	cal/g
<u>Heat of Sublimation:</u>		Btu/lb_m	cal/g

PROPERTIES OF ALUMINUM + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5	528	Alloy No. 2024-5-T4; nominal: 3.8-4.9% Cu; 1.2-1.8% Mg, 0.3-0.9% Mn	ρ: weight and volume by water displacement	
□	Anon.	50-17	Room 1430 1430	Alloy C-46; nominal: 10% Cu; 1.5% Ni; 1% Si; 0.25% Mn, 0.15% Ti	ρ: not given MP: not given Δh_f: not given	Heated 6 - 12 hr. at 500 °C; quenched in water at 60-100 °
△	Anon.	50-16	528 1459	Duralite or Thermafond C3-UNA; nominal 3% Cu; 1.5% Fe; 0.7% Si; 0.6% Mg; 0.6% Ni; 0.15% Ti	ρ: not given MP: not given	Wrought, held 4-8 hr. at 360 °C, cooled to 250 °C, sheets heated 1/2 hr. at 520-530 °C (forgings 4-6 hr. at 525 °C), water tempered, aged 20 hr. at 160 °C, stabilized 2 hr. at 225 °C
◇	Ibid.	50-16	528 1459 1459	Same as above	ρ: not given MP: not given Δh_f: not given	Cast, held 4 - 8 hr. at 360 °C, 4 - 20 hr. at 520 - 530 °C; water tempered, aged 20 hr. at 120 °C; stabiliz 12 hr. at 225 °C
◺	Lucks, C. F., Thompson, H. B. et al.	51-65	528	24S Al. nominal: 4.5% Cu; 1.5% Mg; 0.6% Mn	ρ: weight in air and in water	Condition T4
▽	Vero, J. A.	[illegible]-69	1415-1421	4.2% Cu; 1.0-1.3% Si; 0.7% Fe; 0.6% Mn; 0.36-0.47% Mg	MP: from dilatation curve with Bollenrath dilatometer; temp. meas. by expansion of Al or Chronin	4 samples with different amounts of Mg + Si

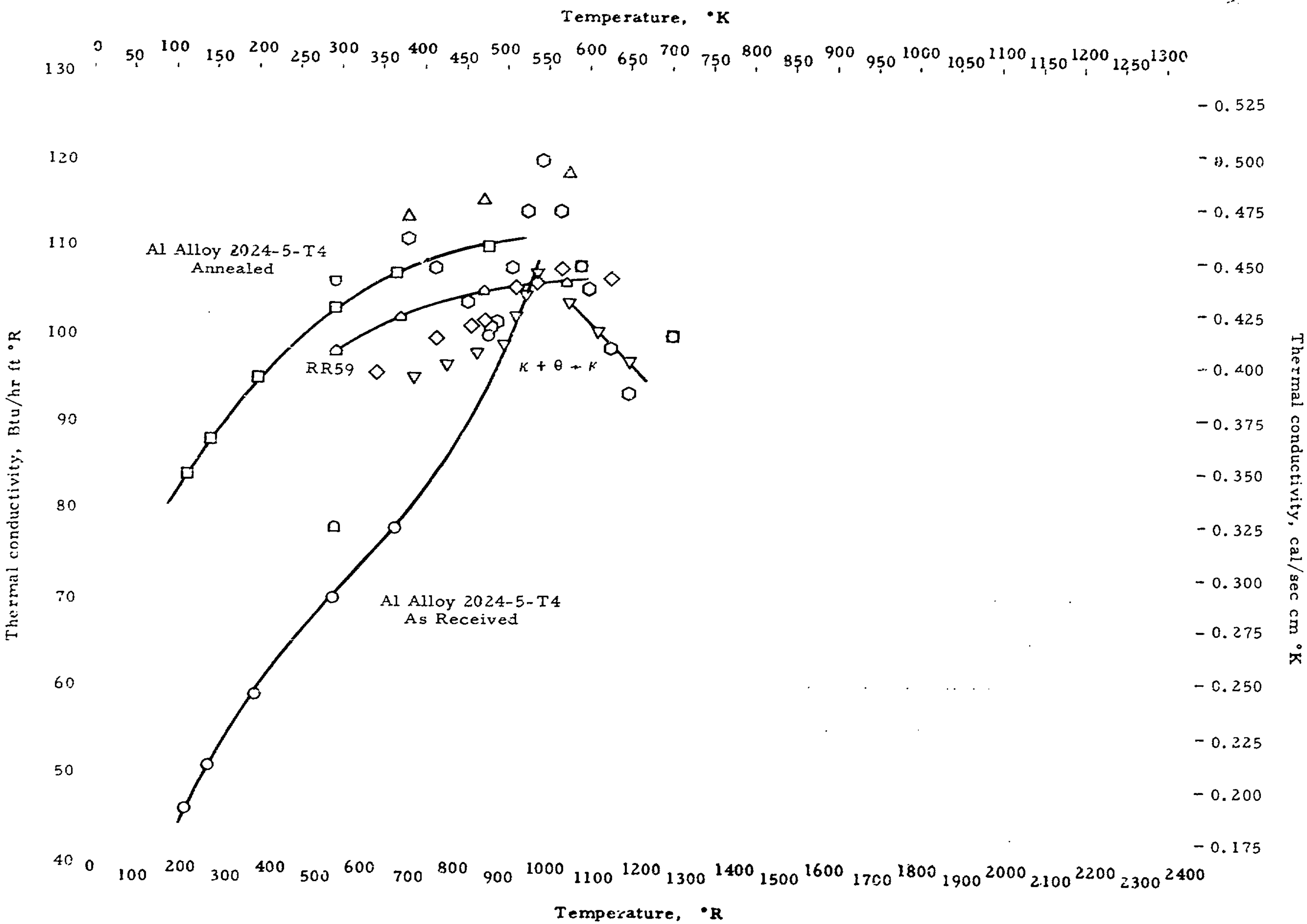


SPECIFIC HEAT -- ALUMINUM + COPPER + X

SPECIFIC HEAT -- ALUMINUM + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Anonymous	50-16	672	"Duralite", Thermofond C3-INA (Ital. Desig.); 3% Cu; 1.5% Fe; 0.7% Si; 0.6% ea. Mn, Ni; 0.15% Ti; $\rho = 170\ lb_m/ft^3$	Not given	Wrought. Heated to 525°C; water quenched, aged 20 hr. at 160°C, 2 hr. at 225°C
□	Polmear, I. J. Hardy, H. K.	55-37	672-1392	4% Cu	Slope of temp. rise curve in electrically heated sample	Forged, solution treated at 530°C, and quenched. Heating rate during test: 1.4 - 2.0°C/min.
△	Ibid.	55-37	672-1392	4% Cu; 0.02% Sn	Same as above	Same as above
◇	Ibid.	55-37	672-1392	4% Cu; 0.05% Sn	Same as above	Same as above
▽	Suzuki, T.	49-25	672-1266	4.31% Cu; 0.29% Si; 0.14% Fe; traces of other impurities	Slope of temp. rise curve in electrically heated sample	Hot worked, annealed several hr. at 500°C in vacuum, cooled in 10 days. Heating rate during tests: 2°C/min.
⬡	Lucks C. F., Matolich, J., and Van Valzor, J. A.	54-27 also 58-5	141-1320	Al alloy 24S-T4; 93.4% Al; 4.5% Cu; 1.5% Mg; 0.6% Mn	Drop method; ice calorimeter	
◺	Anonymous	50-17	672	Alloy C-46 (Ital. Desig.); 10% Cu; 1.5% Ni; 1.0% Si; 0.25% Mn; 0.15% Ti	Not given	Preheated 6 - 12 hr. at 500°C, water quenched at 60 - 100°C

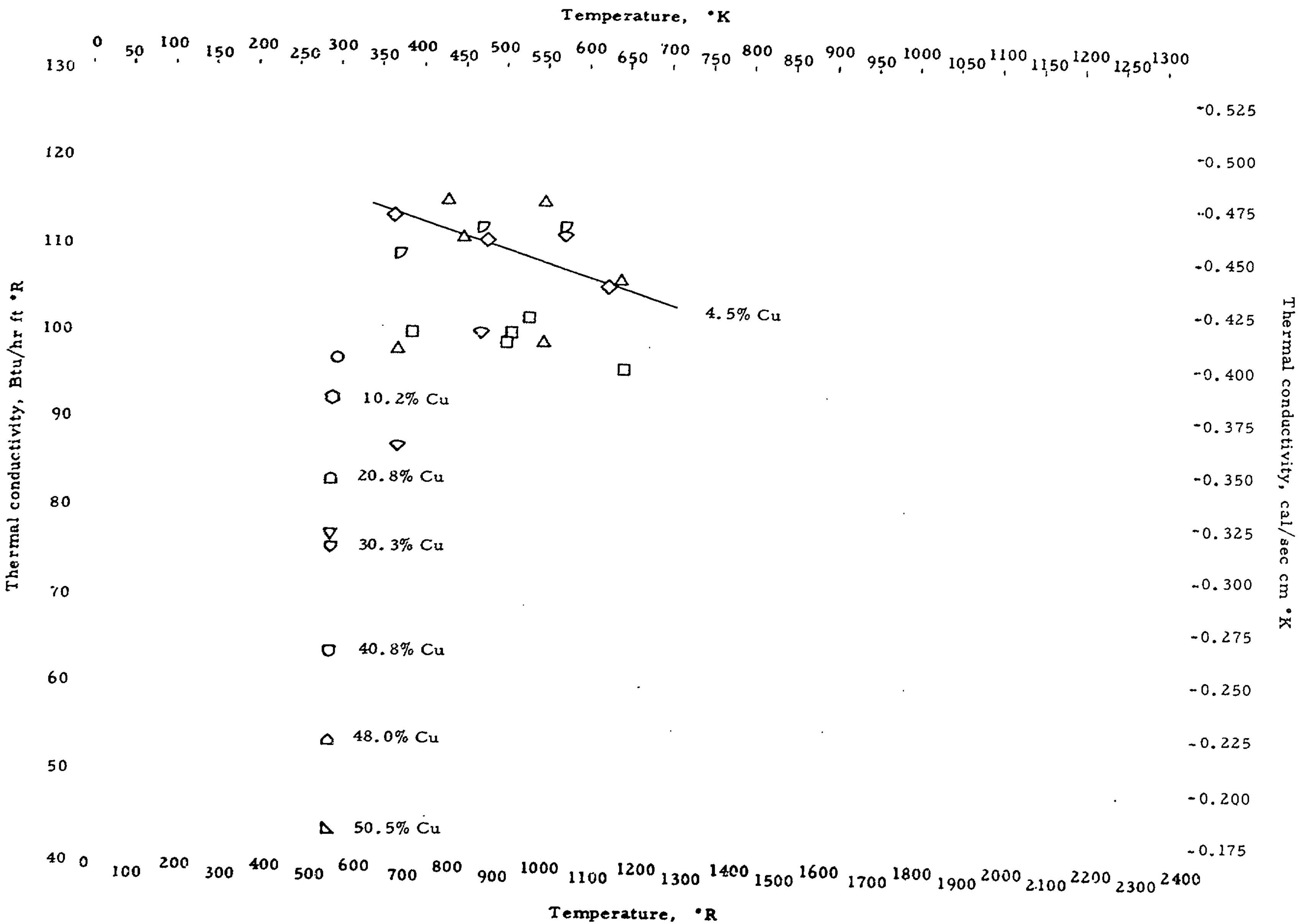


THERMAL CONDUCTIVITY -- ALUMINUM + COPPER + MAGNESIUM + X

THERMAL CONDUCTIVITY -- ALUMINUM + COPPER + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5 also 51-65	210-1260	Al alloy 2024-5-T4; nominal; 3.8 - 4.9% Cu; 1.2 - 1.8% Mg; 0.3 - 0.9% Mn. ρ = 174 lb_m/ft^3	Comparative; rods (Armco Iron standard)	As received
□	Ibid.	58-5 51-65	210-1260	Same as above	Same as above	After heating above 575°F
△	Bungardt, W. and Kallenbach, R.	51-25	672-1036	94.06% Al; 4.10% Cu; 1.63% Mg; 0.10% Fe; 0.06% Si; 0.05% Zn; 0.004% Ti; traces of Mn	Axial heat flow in rod; guarded heat source and sample	Annealed 1 hr. at 500°C; 23 hr. at 400°C; 40 hr. at 300°C. Auth. est. accuracy < ± 3%
◇	Ibid.	51-25	618-1127	93.60% Al; 4.25% Cu; 1.59% Mg; 0.36% Fe; 0.16% Si; 0.02% Zn; 0.01% Mn; 0.007% Ti	Same as above	Repeatedly heated inside the apparatus until middle of rod was at 300°C. Auth. est. accuracy < ± 3%
▽	Evans Jr., J. E.	51-16	685-1167	Al alloy 24S: 4.5% Cu; 1.5% Mg; 0.6% Mn	Comparative; rods (Pb standard)	Run 1: heated from virgin conditions to max. temp. of 707°F. Auth. est. accuracy ± 4%
◯	Ibid.	51-16	683-1167	Same as above	Same as above	Run 2: after cooling to room temp. and repeating. Auth. est. accuracy ± 4%
◯	Garth, R. C. and Sailor, V. L.	49-47	Room	Al Alloy 24S	Radial heat flow in cylinder without guard heaters. Fe-Const. thermocouple	Condition -T4-T3 Auth. est. accuracy ± 5%
◯	Ibid.	49-47	Room	Same as above	Same as above	Condition - O annealed. Auth. est. accuracy ± 5%
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	520-1035	British Desig. RR59: 2.31% Cu; 1.46% Mg; 1.23% Fe; 1.20% Ni; 0.88% Si; 0.07% Ti	Comparative; rods with heated guard tube. Temp. gradient by Nichrome-Const. thermocouple	2 hr. at 525°C, quenched, 16 hr. at 170°C, quenched

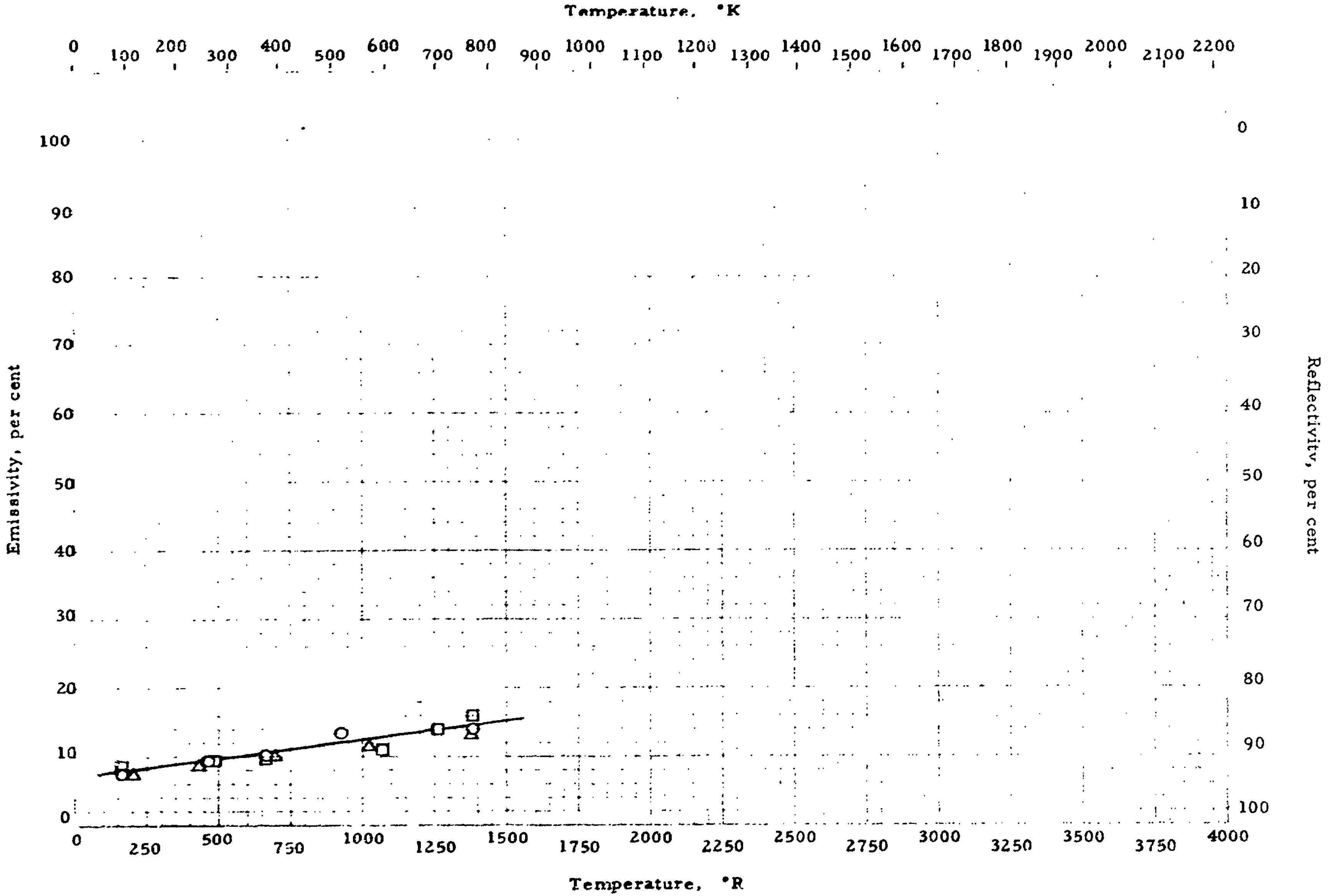


THERMAL CONDUCTIVITY -- ALUMINUM + COPPER + X

THERMAL CONDUCTIVITY -- ALUMINUM + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Anon.	50-16	537	Duralite or Thermafond C3-INA; 3% Cu; 1.5% Fe; 0.7% Si; 0.6% ea. Mg, Ni; 0.15% Ti (Italian)	Not given	Same results for cast and wrought samples
□	Evans Jr., J. E.	51-16	660-1160	Al alloy 14 ST; 4.4% Cu; 0.8% ea. Si, Mn; 0.4% Mg	Comparative; rods (Pb standard)	Run 1: heated from virgin condition to max. temp. of 700 °F. Auth. est. accuracy of ± 4%
△	Ibid.	51-16	660-1160	Same as above	Same as above	Run 2: after cooling to room temp. and repeating. Auth. est. accuracy of ± 4%
◇	Ibid.	51-16	660-1160	Same as above	Same as above	Stabilized for 50 hr. at 775 °F. Auth. est. accuracy of ± 4%
▽	Anon.	50-17	528	10% Cu; 1.5% Ni; 1% Si; 0.25% Mn; 0.15% Ti. ρ = 184 lb_m/ft^3	Not given	Preheated 6 - 12 hr. at 500 °C; water quenched
○	Aleev, N. A.	56-33	528	10.24% Cu	Not adequately described	Annealed 5 hr. at temp. near M. P. furnace cooled
◠	Ibid.	56-33	528	20.78% Cu	Same as above	Same as above
▽	Ibid.	56-33	528	30.32% Cu	Same as above	Same as above
◡	Ibid.	56-33	528	40.82% Cu	Same as above	Same as above
△	Ibid.	56-33	528	48.00% Cu	Same as above	Same as above
◺	Ibid.	56-33	528	50.45% Cu	Same as above	Same as above
◇	Powell, R. W. Hickman, M. J. and Barber, C. R.	49-54	528-1032	Aluminum Alloy (Y alloy, British desig.); 3.76% Cu; 1.85% Ni; 1.33% Mg; 0.45% Si; 0.46% Fe	Comparative; rods with heated guard tube. Temp. gradient by Nichrome-Const. thermocouple	As received
▽	Ibid.	49-54	528-1032	Same as above	Same as above	Heated to 511 °C, quenched in hot water, aged at room temp.

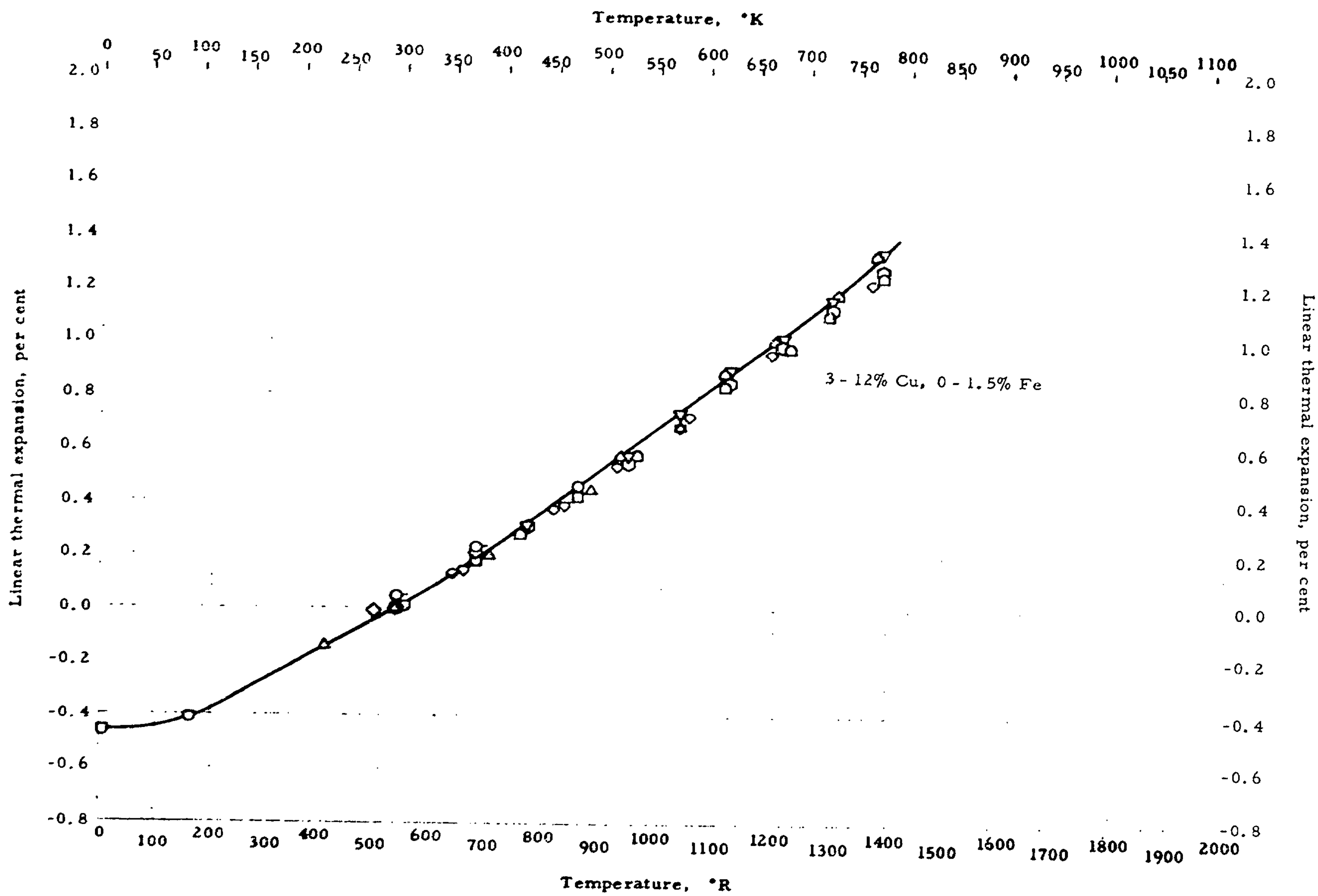


EMISSIVITY -- ALUMINUM + COPPER + MAGNESIUM + X
(Alloy 2024)

EMISSIVITY -- ALUMINUM + COPPER + MAGNESIUM + X
(Alloy 2024)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G. B.	54-122	150-1400	Al Alloy 24ST Nominal: 4.5% Cu; 1.5% Mg; 0.6% Mn	Total normal emissivity: comparative, radiant heat flow compared with that of a black body. Tested in vac. of 10μ Hg	As received: wiped with toluene until clean, then with alcohol
□	Ibid.	54-122	150-1400	Same as above	Same as above	Clean and smooth: scrubbed with soap, washed with water, dried, wiped with toluene and then with alcohol
△	Ibid.	54-122	150-1400	Same as above	Same as above	Polished: buffed until mirror-like and free of scratches, washed with soap and dried



LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + IRON + X

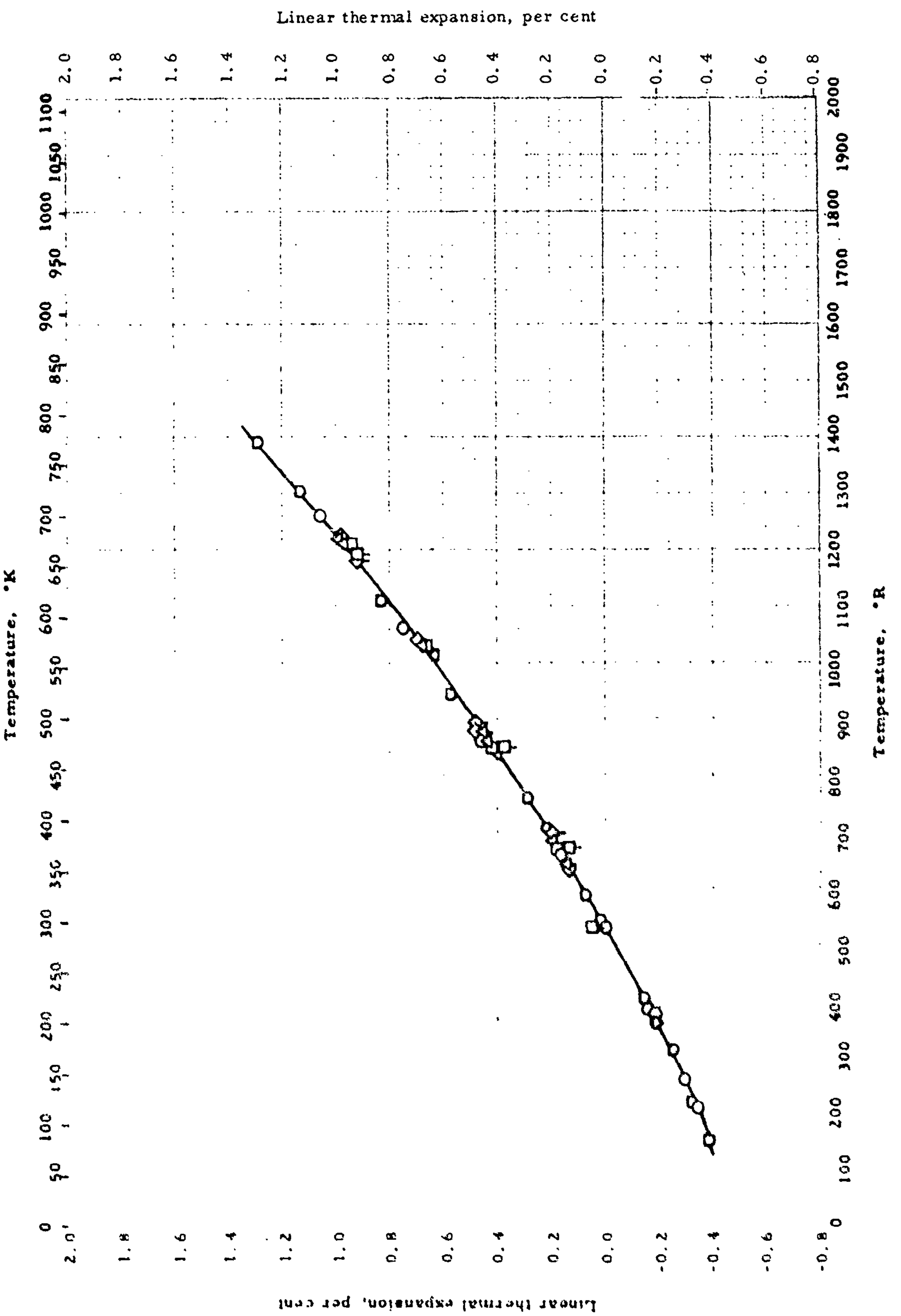
LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Krider, H. S.	52-70	528-852	88.3% Al, 10.09% Cu 1.14% Fe, 0.26% Mg; 0.21% Si	Above room temp. - telemicroscopes sighting on wires suspended from sample. Below room temp. fused quartz tube dilatometer	
□	Ibid.	52-70	528-852	Same as above	Same as above	Cast, heated to 750°F; cooled very slowly. Heating and cooling curves are graphically identical.
△	Ibid.	52-70	402-1032	89.3% Al, 9.0% Cu, 1.0% Fe; 0.4% Si, 0.3% Mg; 0.03% Mn	Same as above	Cast, heated 20 hr. at 225°C, air cooled.
	Ibid.	52-70	402-1032	87.30% Al, 11.88% Cu; 0.43% Fe; 0.39% Si	Same as above	Cast, heated to 500°C, cooled slowly. Reheated to 300°C, cooled slowly. This sample and the following four samples gave both heating and cooling curves graphically identical to above
	Ibid.	52-70	402-1032	89.22% Al, 9.95% Cu; 0.44% Fe; 0.39% Si	Same as above	Treatment same as above
	Ibid.	52-70	402-1032	91.13% Al, 7.87% Cu; 0.45% Fe; 0.33% Si; 0.22% Mn	Same as above	Same as above
	Ibid.	52-70	402-1032	91.14% Al; 7.68% Cu; 0.46% Fe; 0.39% Si; 0.33% Mn	Same as above	Same as above
	Ibid.	52-70	402-1032	93.41% Al, 5.81% Cu; 0.42% Fe; 0.36% Si	Same as above	Same as above
◇	Anon.	50-16	492-672	Duralite or Thermafond C3-INA 3% Cu, 1.5% Fe; 0.7% Si; 0.6% ea. Mn, Ni; 0.15% Ti, $\rho = 170$ lb$_m$ ft^3	Not given	Wrought, held 4-8 hr. at 360°C, cooled to 250°C, heated 1/2 hr. at 520-530°C for sheets (4-6 hr. at 525°C for forgings) water quenched, aged 20 hr. at 160°C, 2 hr at 225°C
▽	Ibid.	50-16	[illegible]	Same as above	Same as above	Cast, held 4-8 hr. at 360°C, 4-20 hr. at 520-530°C; water quenched, aged 20 hr. at 120°C, 2 hr. at 225°C
○	Bollenrath, F. and Hauk, V.	48-1	528-1392	5.08% Cu, 0.15% Fe; 0.05% ea. Si, Zn; 0.02% Ti, traces of Mg and Mn	Comparative dilatometer	Heated 6 hr. at 520°C, water quenched, initial test
▽	Ibid.	48-1	528-1392	Same as above	Same as above	Second heating
◻	Ibid.	48-1	528-1392	7.36% Cu; 0.15% Fe; 0.05% ea. Si, Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Heated 6 hr. at 520°C; water quenched, initial test
△	Ibid.	48-1	528-1392	Same as above	Same as above	Second heating

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
□	Fraser, D. B. and Hollis-Hallet, A. C.	55-28	7-540	Duralumin. Nominal: 3.5 - 4.5% Cu; others same as 17S	Observed separation of 2 Hg lines from diffraction grating ruled on the sample. Sample temp. measured by boiling pts. of various fluids	
○	Univ. of Chicago Metallurgical Lab.	43-19	528-1392	17ST Al. Nominal: 3.5 - 4.5% Cu; 1% Fe; 0.4 - 1.0% Mn; 0.8% Si; 0.2 - 0.8% Mg; 0.25% Zn; 0.1% Cr	Not given	

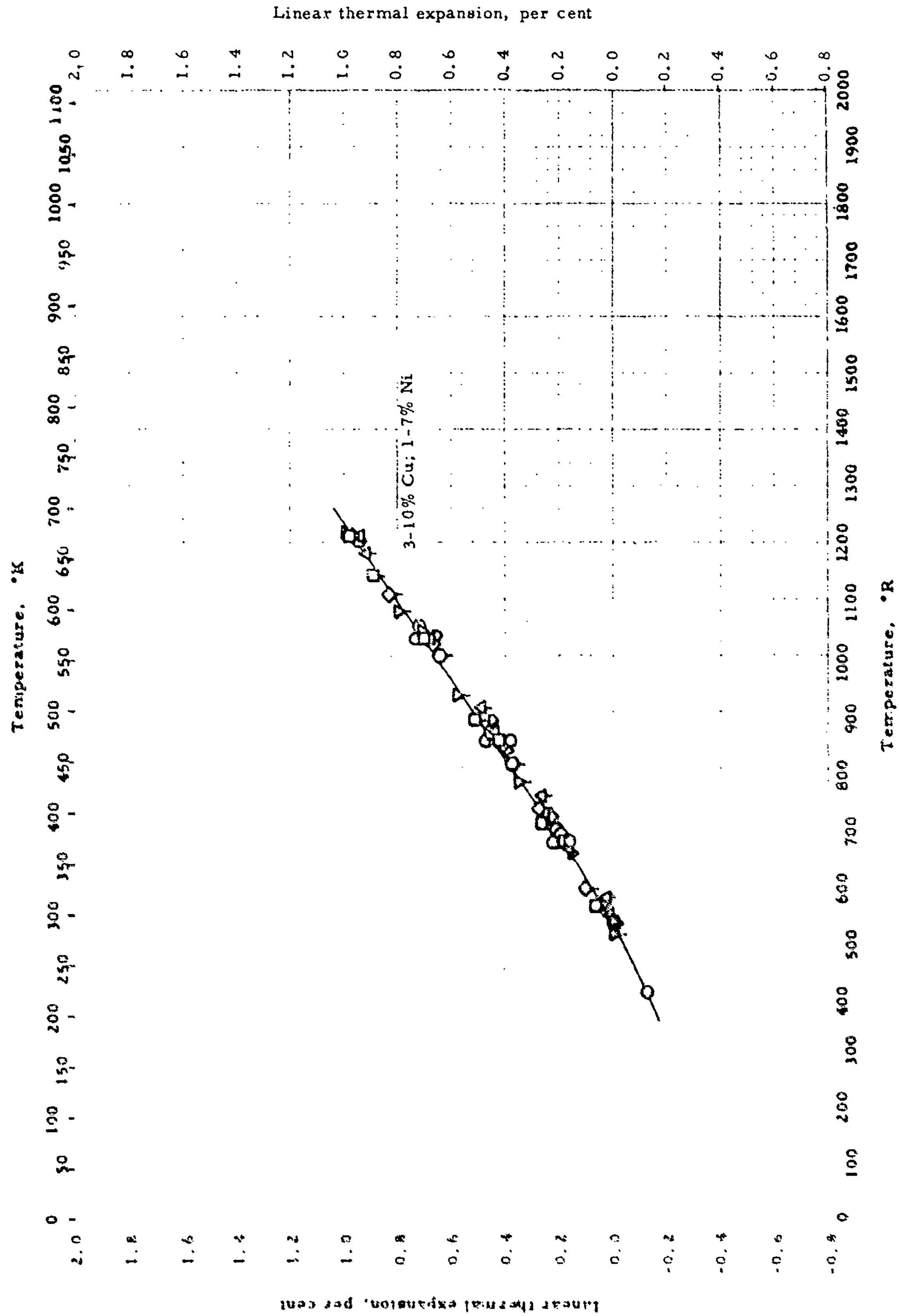


LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + MAGNESIUM + X
(3 - 5% Cu, 1 - 2% Mg)

LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + MAGNESIUM + X
(3 - 5% Cu, - 2% Mg)

REFERENCE INFORMATION

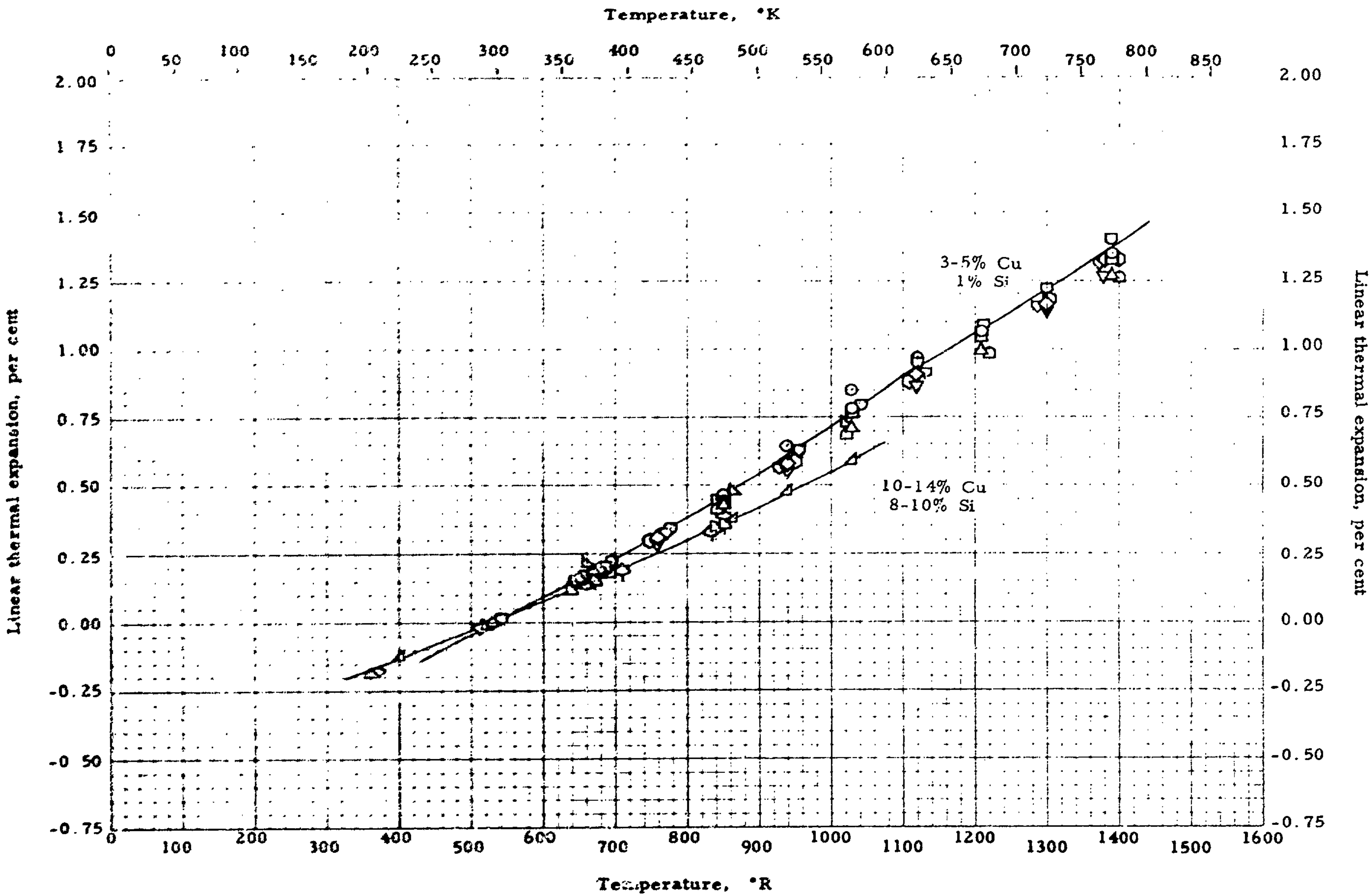
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	53-5	216-1260	Al alloy 2024-S-T4, nominal: 3.8 - 4.9% Cu; 1.2 - 1.8% Mg, 0.3 - 0.9% Mn	Quartz tube dilatometer	Tested in vacuum
□	Hidnert, P. and Krider, H.S.	52-70	528-1212	93.09% Al; 4.43% Cu; 1.41% Mg, 0.67% Mn; 0.25% Fe, 0.10% Si, 0.02% Zn; 0.01% ea. Ni, Cr, Pb, Bi	Telemicroscopes sighting on wires suspended from sample	Solution heat treated 1 hr. at 920°F; water quenched; aged at room temp. □ - heating ◻ - cooling
△	Ibid.	52-70	528-1212	Same as above	Same as above	Same treatment as above; then aged 100 hr. at 700°F △-heating △ - cooling
◇	Ibid.	52-70	528-1212	Same as above	Same as above	Same treatment as above; then aged 500 hr. at 800°F ◇-heating ◇ - cooling
▽	Perry, S.	45-6	360-528	Al alloy 24SRT (or 2024-T36) 9.34% Al; 4.5% Cu; 1.5% Mg, 0.6% Mn	Quartz tube dilatometer	Solution heat treated; cold worked. Auth. est. accuracy ± 3.4%
○	Ibid.	45-6	360-528	Al alloy 24 ST 81 (or 2024-T81), analysis same as above	Same as above	Solution heat treated, cold worked; aged for 12 hr. at 375°F. Auth. est. accuracy ± 3.4%
○	Ibid.	45-6	360-528	Al alloy 24 ST (or 2024-T4) analysis same as above	Same as above	Solution heat treated for 10 - 60 min. at 920°F in salt bath; cold water quenched; aged 48-96 hr. at room temp. Auth. est. accuracy ± 3.4%
○	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	672-1032	Aluminum Alloy RR 59 (British desig.) 2.31% Cu, 1.46% Mg; 1.23% Fe, 1.20% Ni; 0.87% Si; 0.07% Ti	Quartz tube dilatometer with dial gauges, in constant temp. bath	Wrought, heated 2 hr. at 525°C, quenched, aged 16 hr. at 170°C, quenched
○	Lucks, C.F., Thompson, H.B. et al	51-65	150-1392	Aluminum alloy 24S: Nominal: 4.5% Cu; 1.5% Mg; 0.6% Mn	Quartz tube dilatometer, tested at 1.5 - 2.5°C/min rise in argon	Condition T4



LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P., and Krider, H.S.	52-[illegible]	402-852	77.99% Al, 7.21% Cu; 7.18% Ni, 6.76% Si; 0.84% Fe	Above 528°R - telemicroscopes sighting on wires suspended from sample; below 528°R - fused quartz tube dilatometer	Annealed
□	Ibid.	52-70	528-1212	92.23% Al, 3.98% Cu, 2.01% Ni; 0.64% Mg; 0.58% Si, 0.45% Fe; 0.05% Mn; 0.02% Zn, 0.01% ea. Cr, Pb, Bi, Ti	Same as above	Solution heat treated 1 hr. at 960°F water quenched, aged 10 hr. at 340°F □ - heating □ - cooling
△	Ibid.	52-70	528-1212	Same as above	Same as above	Same treatment as above, then aged 100 hr. at 700°F △ - heating △ - cooling
◇	Ibid.	52-70	528-1212	Same as above	Same as above	Same treatment as above, then aged 500 hr. at 800°F ◇ - heating ◇ - cooling
▽	Ibid.	52-70	528-1212	91.56% Al, 3.89% Cu, 2.14% Ni, 1.45% Mg, 0.58% Si, 0.31% Fe, 0.01% Ti, 0.02% Zn, 0.01% ea. Mn, Cr, Pb, Bi	Same as above	Same treatment as above; then aged 10 hr. at 340°F ▽ - heating ▽ - cooling
○	Ibid.	52-70	528-1212	Same as above	Same as above	Same treatment as above; then aged 10 hr. at 700°F ○ - heating ○ - cooling
○	Anonymous	50-17	528-1032	10% Cu, 1.5% Ni, 1% Si, 0.25% Mn, 0.15% Ti; $\rho = 184\ lb_m/ft^3$	Not given	Preheated 6-12 hr. at 500°C; water quenched
▽	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	672-[illegible]	Aluminum [illegible] alloy (British Designation) 1.76% Cu, 1.45% Ni, 1.33% Mg, 0.45% Si, 0.40% Fe	Quartz tube dilatometer with dial gauges, in constant temp. bath	Plotted data avg. of two samples (within ± 0.5%). Sample a, wrought, sample b, heated 510° C, quenched in hot water, aged at room temp.

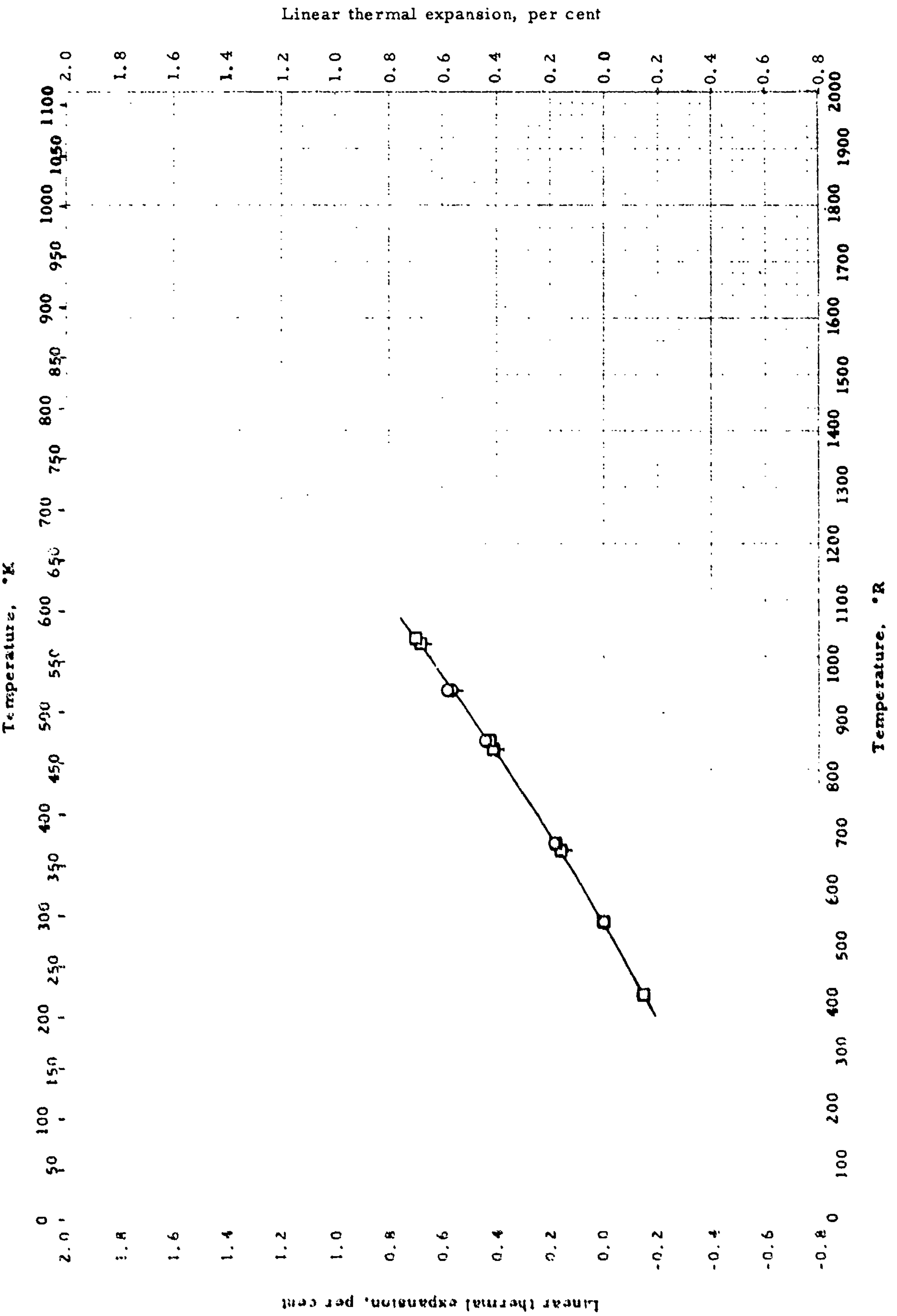


LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + SILICON + X

LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bollenrath, F., and Hauk, V.	48-1	528-1392	5.02% Cu, 1.06% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Dilatometer	Cast. Held 6 hr. at 520°C, water quenched. Heated at 1.5°C/min. during test
□	Ibid.	48-1	528-1392	Same as above	Same as above	Same as above. Data shown for second heating cycle
△	Ibid.	48-1	528-1392	5.08% Cu; 0.15% Fe; 0.05% ea. Si, Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Cast. Held 6 hr. at 520°C, water quenched. Heated at 1.5°C/min. during test
◇	Ibid.	48-1	528-1392	Same as above	Same as above	Same as above. Data shown for second heating cycle
▽	Ibid.	48-1	528-1392	5.24% Cu, 2.10% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Cast. Held 6 hr. at 520°C, water quenched. Heated at 1.5°C/min. during test
○	Ibid.	48-1	528-1392	Same as above	Same as above	Same as above. Data shown for second heating cycle
□	Ibid.	48-1	528-1392	7.36% Cu; 0.15% Fe; 0.05% ea. Si, Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Cast. Held 6 hr. at 520°C, water quenched. Heated at 1.5°C/min. during test
▽	Ibid.	48-1	528-1392	Same as above	Same as above	Same as above. Data shown for second heating cycle
□	Ibid.	48-1	528-1392	3.00% Cu, 6.99% Si, 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Cast. Held 6 hr. at 520°C, water quenched. Heated at 1.5°C/min. during test
△	Perry, S.	45-6	360-528	Al alloy 195T4; 4.5% Cu	Quartz tube dilatometer	Solution heat treated 12 hr. at 960°F; water cooled to 150-212°F, naturally aged. Auth. est. accuracy ± 3.4%
▽	Ibid.	45-6	360-528	Al alloy 14ST (2014-T6), 4.4% Cu; 0.8% ea. Si, Mn; 0.4 Mg	Same as above	Solution heat treated, aged 10 hr. at 340°F. Auth. est. accuracy ± 3.4%
◁	Anonymous	50-17	528-1032	Al alloy No. C-46; 10% Cu; 1.5% Ni; 1% Si; 0.25% Mn, 0.15% Ti; ρ = 184 lb_m/ft^3	Not given	Preheated 6-12 hr. at 500°C; water quenched at 60-100°C
◇	Hidnert, P., and Krider, H. S.	52-70	528-852	9.86% Cu; 9.79% Si; 4.03% Ni, 0.30% Fe	Below room temp.: fused quartz tube dilatometer; above room temp.: telemicroscopes sighting on wires suspended from sample	Cast in iron mold ◇ : heating ◇ : cooling
▷	Ibid.	52-70	528-852	Same as above	Same as above	Heated to 400°C; cooled very slowly ▷ : heating ▷ : cooling
◁	Ibid.	52-70	492-1032	14.14% Cu; 8.21% Si; 0.81% Fe	Same as above	Normalized 1 hr. at 400°C; cooled slowly

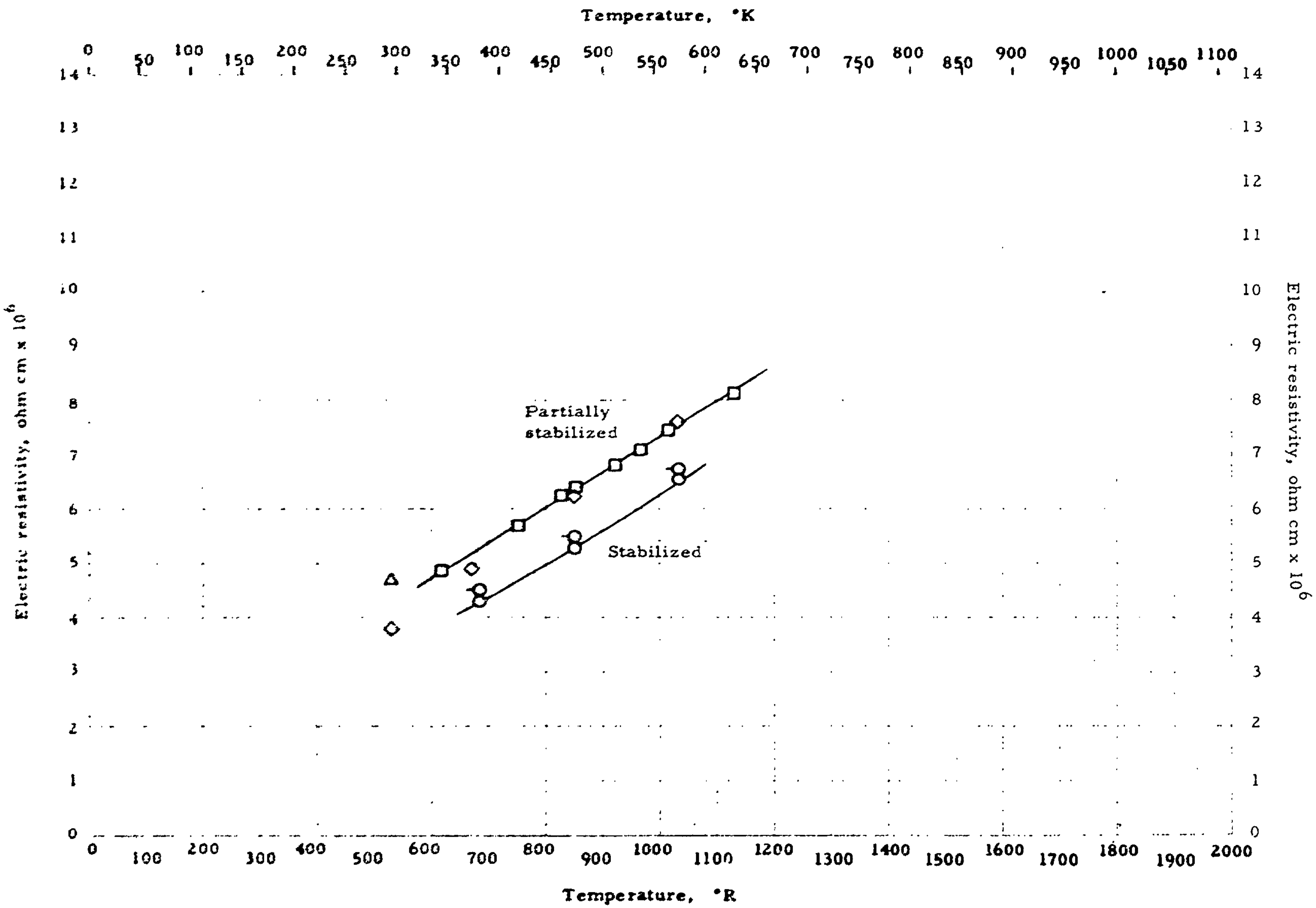


LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + TIN + X

LINEAR THERMAL EXPANSION -- ALUMINUM + COPPER + TIN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○ ⚲	Hidnert, P., and Krider, H.S.	52-70	402-1032	94.0% Al; 1.8% Cu; 1.3% Sn; 1.1% Zn; 0.6% ea. Mg, Fe; 0.23% Ti; 0.2% ea. Cr, Si; 0.02% Mn	Above 528°R - telemicroscopes sighting on wires suspended from sample. Below 528°R - fused quartz tube dilatometer	Sand cast ○ - heating; ⚲ - cooling
□ ⚲	Ibid.	52-70	402-1032	Same as above	Same as above	Rolled, heated 2 hr. at 650 °F, furnace cooled □ - heating; ⚲ - cooling

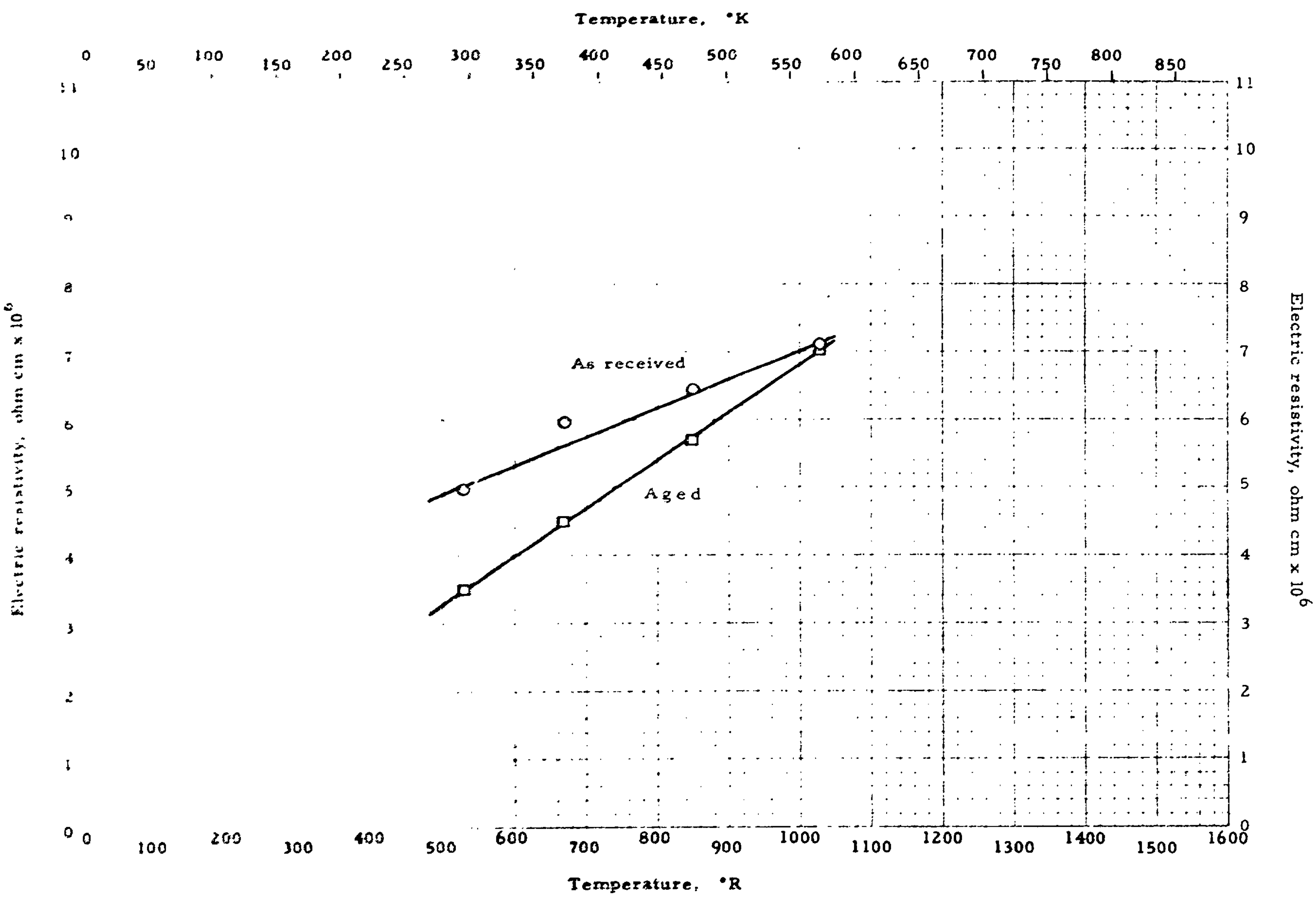


ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + MAGNESIUM + X

ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bungardt, W. and Kallenbach, R.	51-25	585-1036	4.10% Cu; 1.63% Mg; 0.1% Fe; 0.06% Si, 0.05% Zn; 0.004% Ti; Traces of Mn	Kelvin double bridge	○ heating; -○ cooling from 400°C. Auth. est. accuracy ± 0.2%. Annealed 1 hr. at 500°C; 23 hr. at 400°C; 40 hr. at 300°C
□	Ibid.	51-25	618-1127	4.25% Cu; 1.59% Mg; 0.36% Fe; 0.16% Si; 0.02% Zn; 0.01% Mn; 0.007% Ti	Same as above	Auth. est. accuracy ± 0.2% Repeatedly heated to 300°C before test
△	Powell, R. W., Hickman, M.J. and Barber, C.R.	49-54	528	Aluminum Alloy RR 59 (British Desig.) 2.31% Cu, 1.46% Mg; 1.23% Fe, 1.20% Ni; 0.88% Si; 0.07% Ti	Potential drop	Wrought
◇	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heated 2 hr. at 525°C, quenched, held 16 hr. at 170°C, quenched

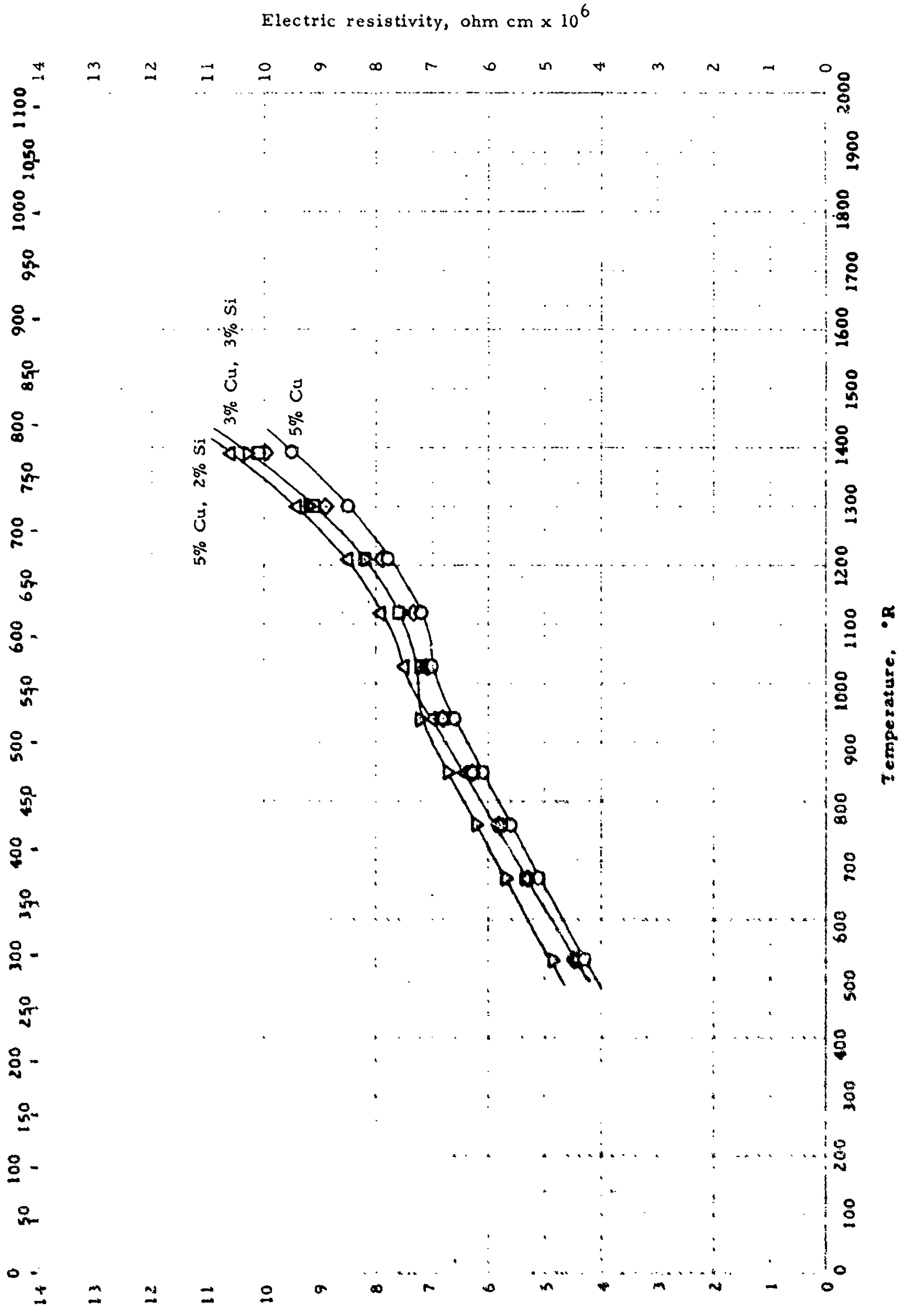


ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + NICKEL + X

ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Al Alloy "Y" (British desig.): 3.76% Cu; 1.85% Ni; 1.33% Mg; 0.45% Si; 0.40% Fe	Potential drop	Wrought, as received
□	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heated to 510 °C, quenched in fairly hot water, aged at room temp.

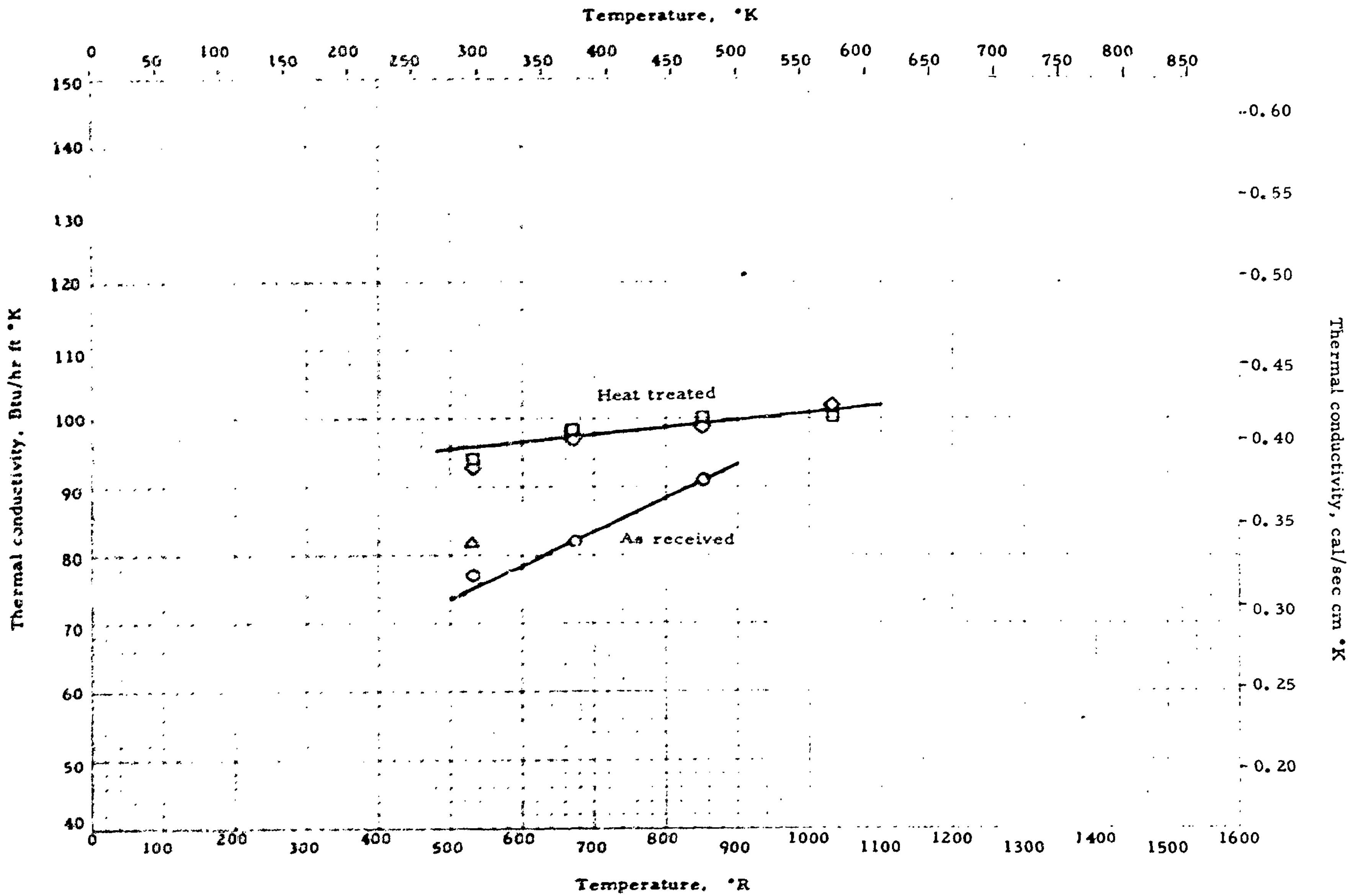


ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + SILICON + X

ELECTRIC RESISTIVITY -- ALUMINUM + COPPER + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bollenrath, F., and Hauk, V.	48-1	528-1932	Cast; 5.08% Cu; 0.15% Fe; 0.05% ea. Si, Zn; 0.02% Ti; traces of Mg, Mn	Kelvin bridge	Heated 6 hr. at 970°F, water quenched
□	Ibid.	48-1	528-1932	Cast; 5.02% Cu; 1.06% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Same as above
△	Ibid.	48-1	528-1932	Cast; 5.24% Cu; 2.10% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Same as above
◇	Ibid.	48-1	528-1932	Cast; 3.0% Cu; 0.99% Si; 0.15% Fe; 0.05% Zn, 0.02% Ti; traces of Mg, Mn	Same as above	Same as above
▽	Ibid.	48-1	528-1932	Cast; 3.06% Si; 3.05% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg, Mn	Same as above	Same as above

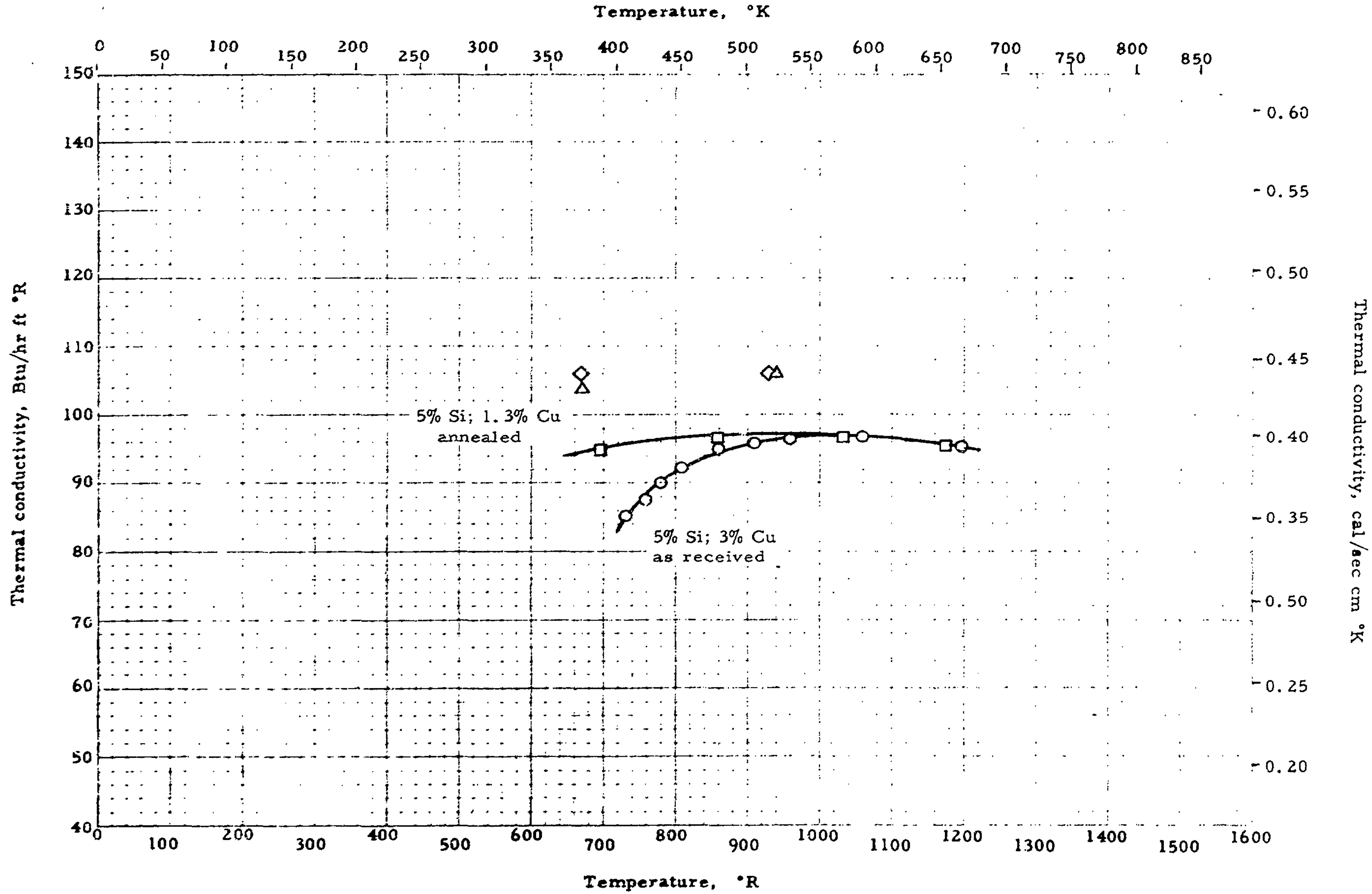


THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER + X
(2-2.5% Si, 1.4% Cu)

THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER + X
(2 - 2.5% Si, 1.4% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Al Alloy RR53C (British desig.): 2.42% Si; 1.33% Cu; 1.32% Fe; 0.87% Ni; 0.50% Mg; 0.15% Ti	Comparative; rods with heated guard tube, temp. gradient by Nichrome-Const. thermocouples	Cast, as received
□	Ibid.	49-54	528-1032	Same as above	Same as above	Cast, held 2 hr. at 530 °C, water quenched, held 15 hr. at 165 °C
△	Ibid.	49-54	528	Al Alloy RR50C (British desig.): 2.25% Si, 1.40% Cu, 1.18% Fe, 0.90% Ni; 0.19% Ti; 0.12% Mg	Same as above	Cast, as received
◇	Ibid.	49-54	528-1032	Same as above	Same as above	Cast, held 10 hr. at 165 °C, air cooled

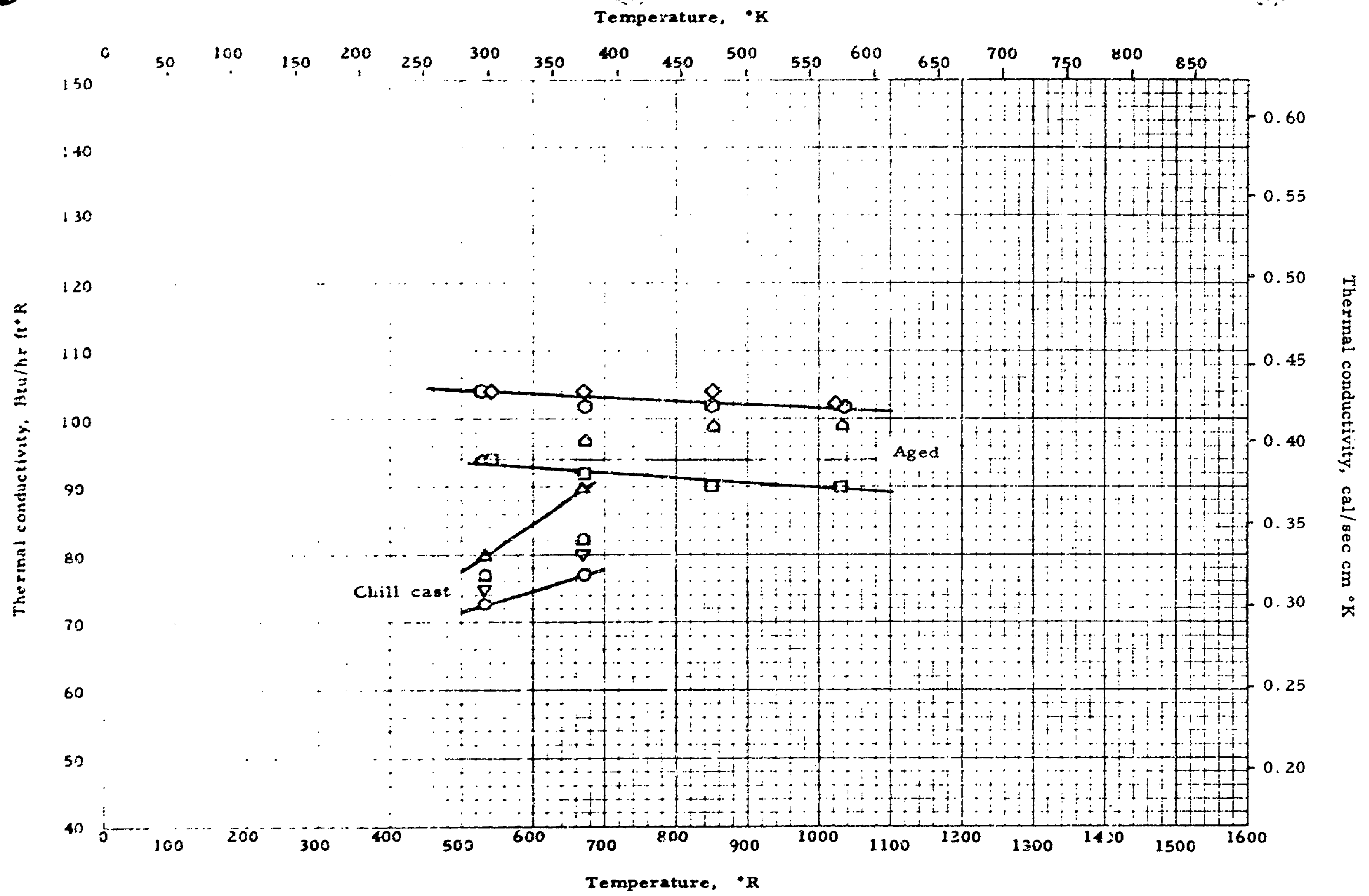


THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER
(5% Si; 1.4% Cu)

THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER
(5% Si; 1.4% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Evans Jr., J. E.	51-16	698-1198	5.0% Si; 1.3% Cu; 0.5% Mg	Comparative; rods (Pb standard)	Run 1: heated from virgin conditions to max. temp. of 707°F. Auth. est. accuracy ± 4%
□	Ibid.	51-16	698-1198	Same as above	Same as above	Run 2: after cooling to room temp. and repeating. Auth. est. accuracy ± 4%
△	Bungardt, W. and Kallenbach, R.	51-25	672-942	91.79% Al; 5.5% Si; 1.43% Cu; 0.42% Mg, 0.41% Fe; 0.27% Mn; 0.14% Zn; 0.04% Ti; heavily gassed	Axial heat flow in rod; guarded heat source and sample	Annealed for 1 hr. at 500 °C; 23 hr. at 400°C; 40 hr. at 300°C. Auth. est. error < ± 3%
◇	Ibid.	51-25	672-942	Same as above; not gassed	Same as above	Same as above

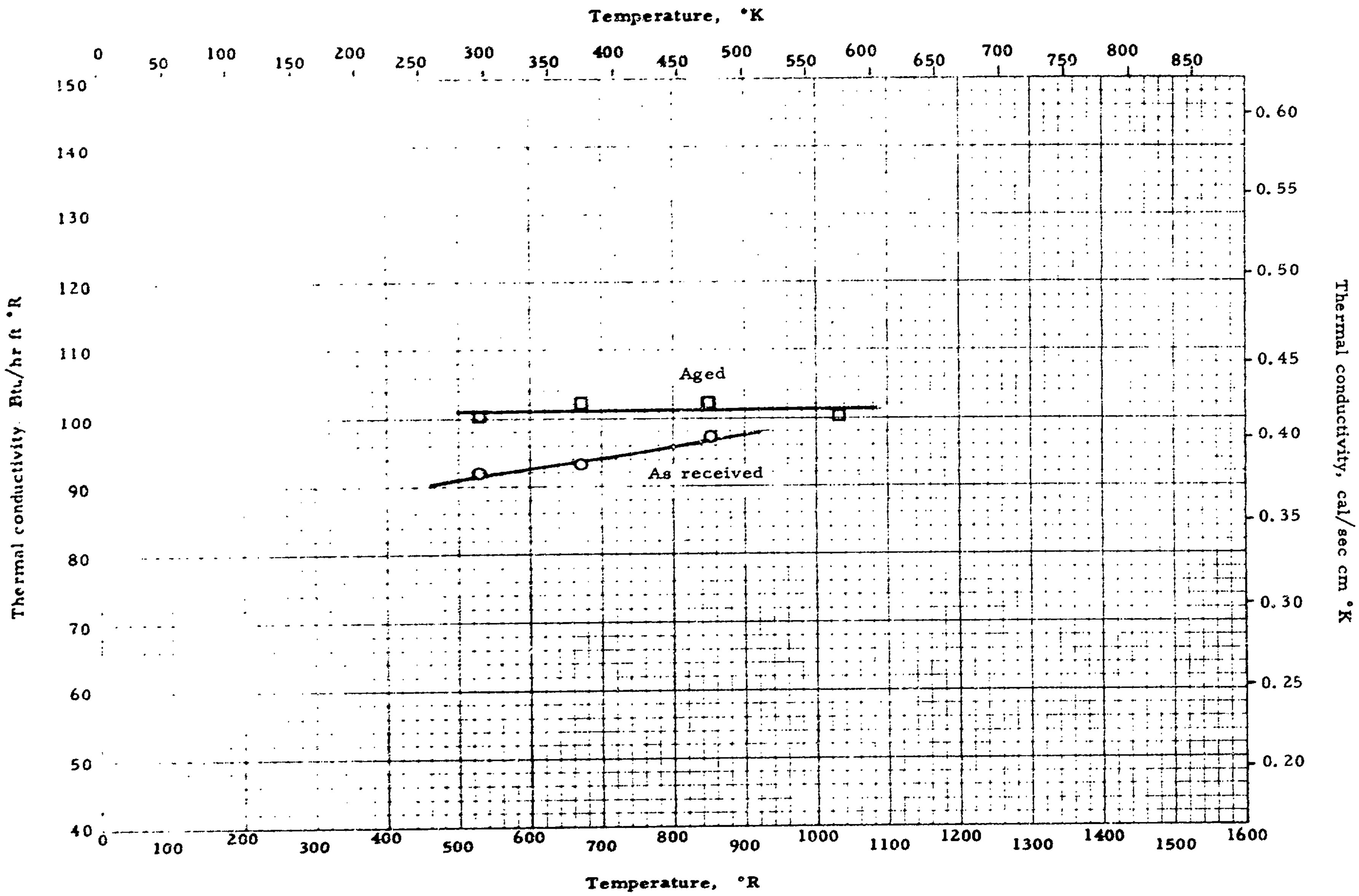


THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER
(11% Si; 5% Cu)

THERMAL CONDUCTIVITY -- ALUMINUM + SILICON - COPPER
(11% Si; 5% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-672	Aluminum Alloy SA 44 (British Desig.) 11.0% Si; 5.0% Cu; 0.5% Mg; <0.5% Fe; 0.4% Mn; 0.3% Co; 0.1% Ti	Comparative; rods, heated guarded tube. Temp. by Nichrome-Const. thermocouple	Chill cast. Range of values ± 8% for different samples
□	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, heated 3 hr. at 500°C, cold water quenched, aged 16 hr. at 165°C. Range of values ± 8% for different samples
⌂	Ibid.	49-54	528-672	Same as above	Same as above	Wrought. Range of values ± 8% for different samples
⌂	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heated 3 hr. at 495°C-500°C, cold water quenched. Aged 16 hr. at 165°C, air cooled. Range of values ± 8% for different samples
△	Ibid.	49-54	528-672	Aluminum Alloy SA1 (British Desig.) 11.0% Si; 5.0% Cu; 0.6% Mg; <0.5% Fe; 0.2% Co; 0.05% Ti	Same as above	Chill cast. Range of values ± 4% for different samples
◇	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, heated 3 hr. at 495°C-500°C, cold water quenched. Aged 16 hr. at 165°C. Range of values ± 4% for different samples
▽	Ibid.	49-54	528-672	Same as above	Same as above	Wrought. Range of values ± 4% for different samples
○	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heated 3 hr. at 495°C-500°C, cold water quenched. Aged 16 hr. at 165°C, air cooled. Range of values ± 4% for different samples

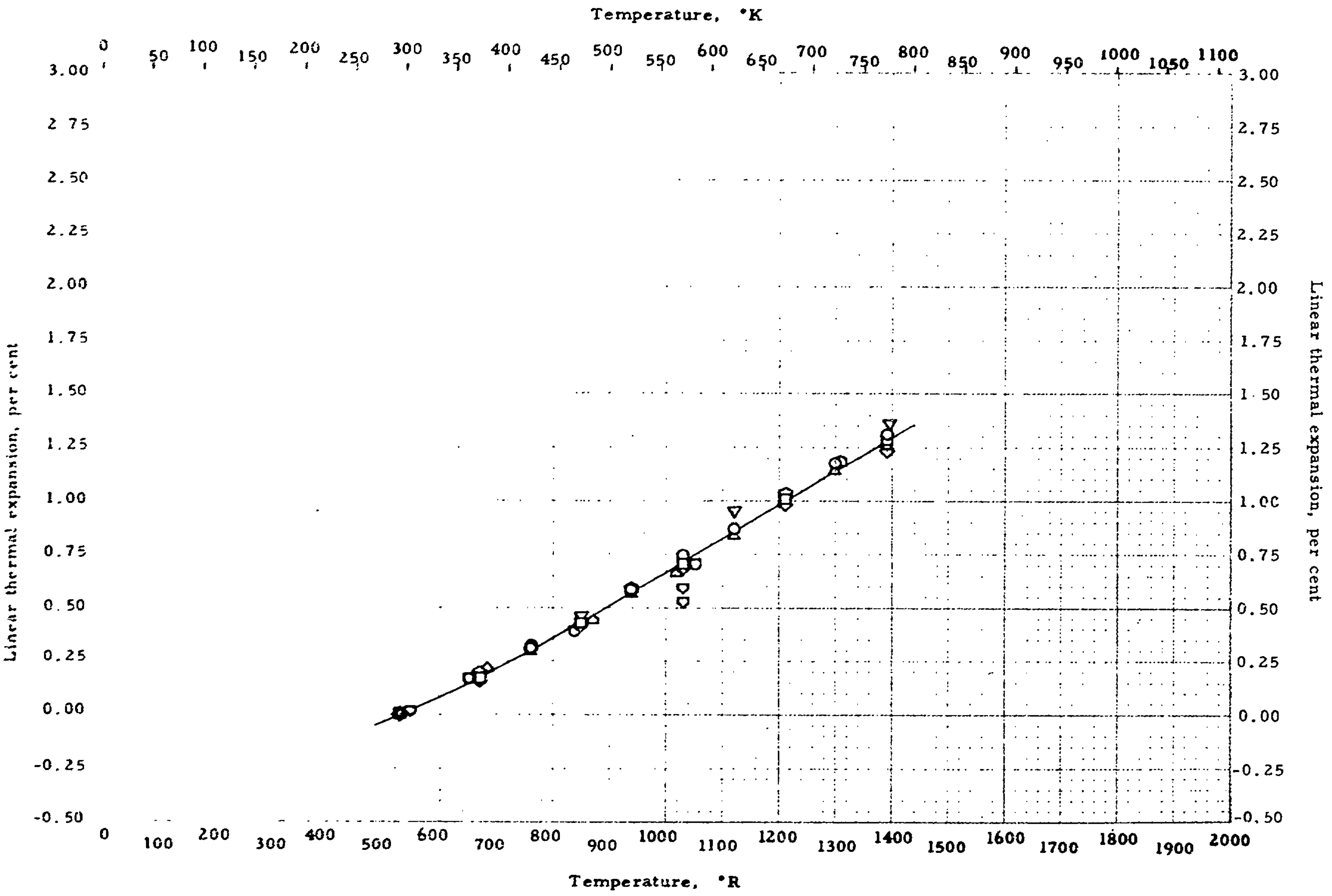


THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER + X
(12% Si; 1% Cu)

THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + COPPER + X
(12% Si; 1% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-852	Al alloy Lo-Ex (British desig.): 11.89% Si; 1.03% Cu; 1.02% Ni; 0.91% Mg; 0.50% Fe; 0.03% Mn; 0.02% Ti	Comparative; rods with heated guard tube, temp. gradient by nichrome-const. thermocouples	Wrought, as received
□	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, held 12 hr. at 520°C, quenched, aged 4 hr. at 135°C, cooled in air, aged 4 hr. at 200°C, air cooled

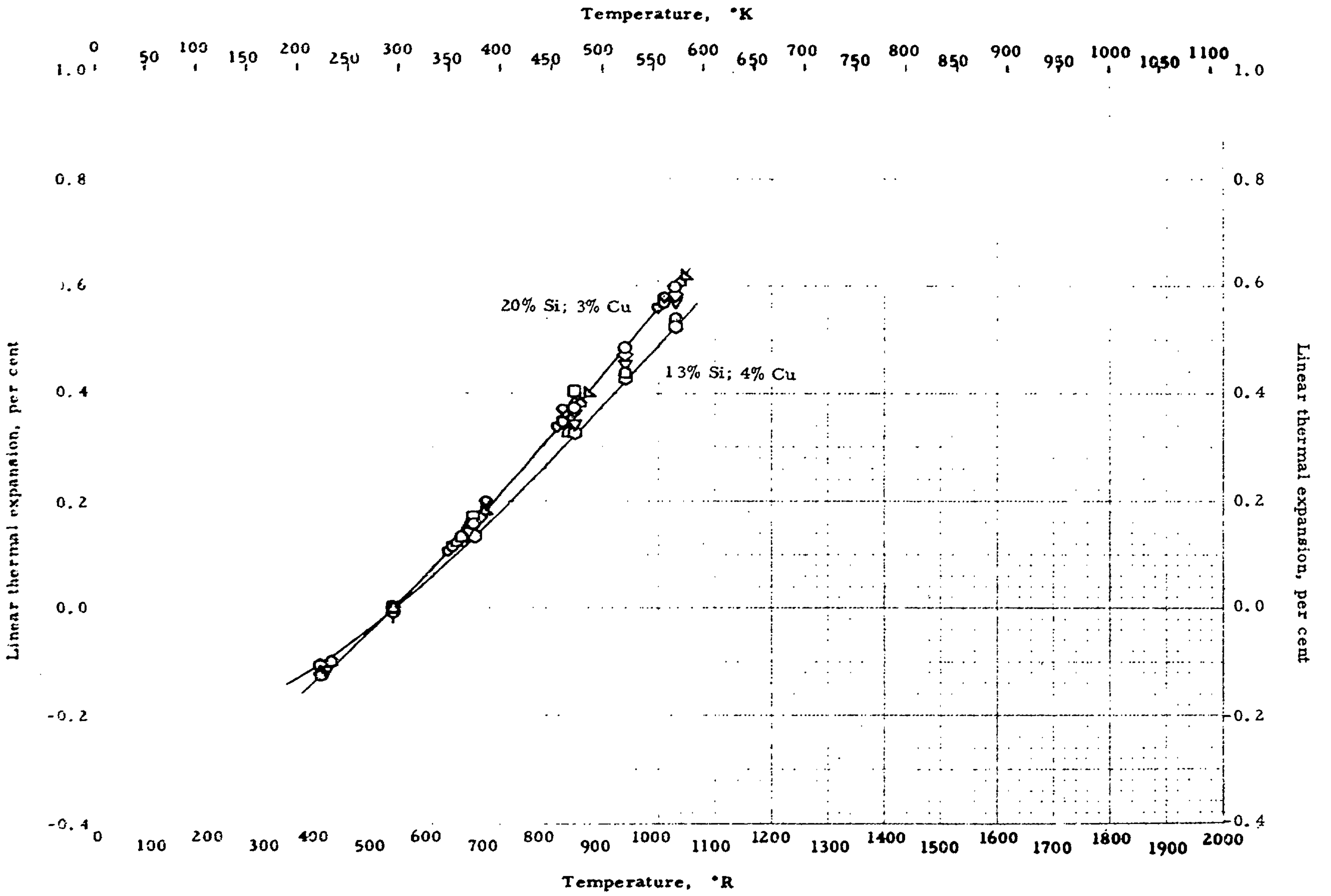


LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + COPPER + X
(1-6% Si; 1-3% Cu)

LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + COPPER + X
(1-6% Si; 1-3% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bollenrath, F. and Hauk, V.	48-1	528-1392	Cast: 3.06% Si; 1.04% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Leitz dilatometer	Held 6 hr. at 520°C, water quenched, annealed by heating to 520°C at 1.5°C/min., cooling at same rate. Temp. measured by noting expansion of calibrated Al rod
□	Ibid.	48-1	528-1392	Cast: 3.95% Si; 1.04% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
△	Ibid.	48-1	528-1392	Cast: 5.00% Si; 1.03% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
◇	Ibid.	48-1	528-1392	Cast: 6.04% Si; 1.05% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
▽	Ibid.	48-1	528-1392	Cast: 3.0% Cu; 0.99% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
○	Ibid.	48-1	528-1392	Cast: 3.06% Si; 3.05% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
□	Ibid.	48-1	528-1392	Cast: 4.0% Si; 3.16% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; traces of Mg and Mn	Same as above	Same as above
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	672-1032	Al Alloy RR53C (British desig.). 2.42% Si; 1.33% Cu; 1.12% Fe; 0.87% Ni; 0.50% Mg; 0.15% Ti	Quartz tube dilatometer constant temp. bath	Cast, heated 2 hr. at 530°C, water quenched, heated 15 hr. at 160-170°C
□	Ibid.	49-54	672-1032	Al Alloy RR50 (British desig.): 2.25% Si; 1.40% Cu; 1.18% Fe; 0.90% Ni; 0.19% Ti; 0.12% Mg	Same as above	Cast, heated 10 hr. at 160 - 170°C, air cooled
▽	Hori, K. and Murohara, M.	54-119	528-1032	Al Alloy: 3.5% Si; 2% Cu; 1.0% Mn; 0.4% ea. Ti, Mg	Not given	Quenched at 520°C, aged at 150 - 170°C for 20 hr.

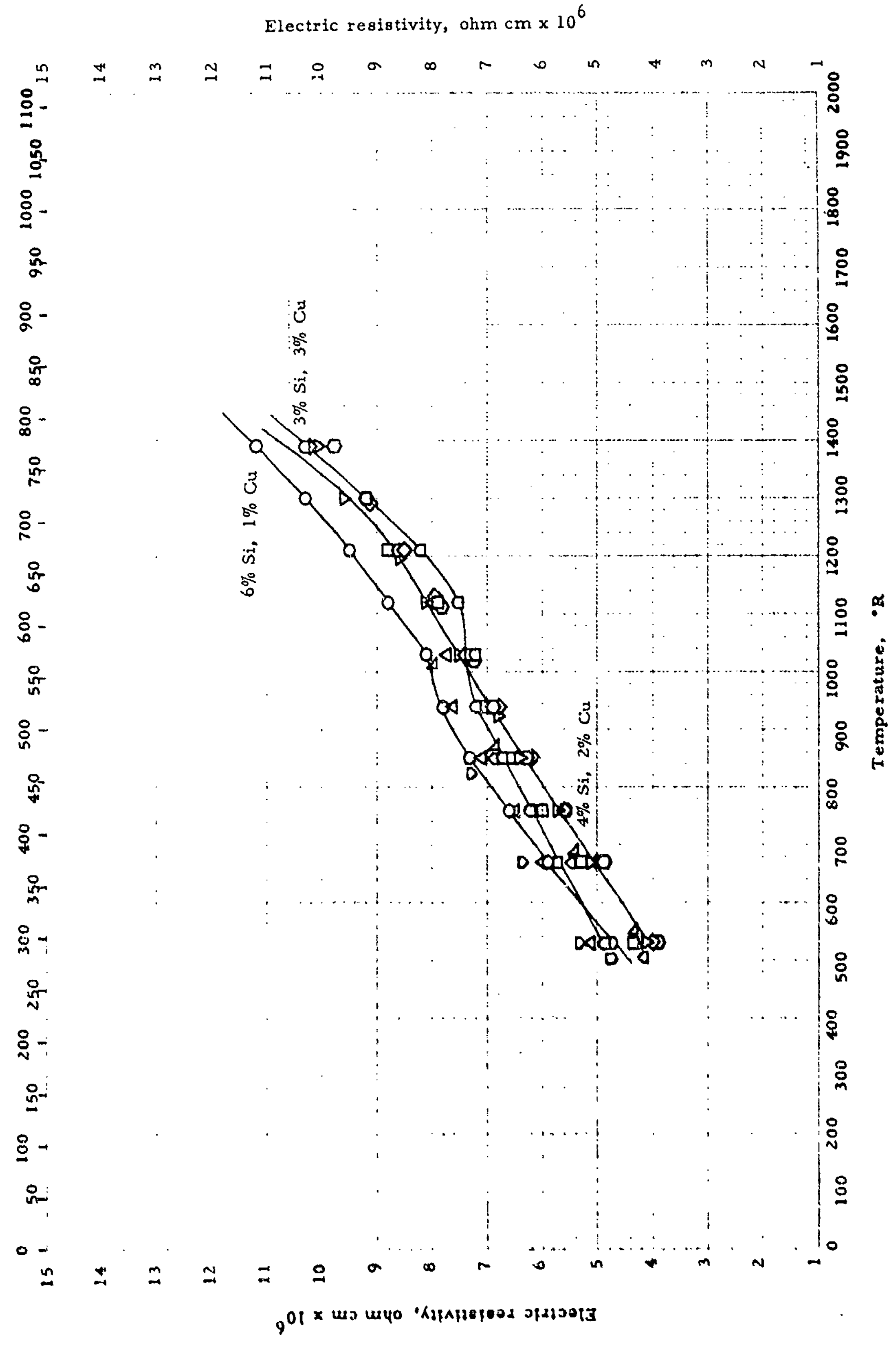


LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + COPPER + X
(10-20% Si; 1-10% Cu)

LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + COPPER + X
(10-20% Si; 1-10% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Krider, H. S.	52-70	402-1032	81.60% Al; 13.35% Si; 4.03% Cu; 0.82% Fe	Below 528°R - fused quartz tube dilatometer. Above 528 °R - telemicroscopes sighting on wires suspended from sample	Normalized 1 hr. at 400°C, cooled slowly. ○ - heating;
□	Ibid.	52-70	528-852	80.45% Al; 10.16% Si; 9.08% Cu; 0.31% Fe	Same as above	Cast in iron mold
△	Ibid.	52-70	528-852	Same as above	Same as above	Heated to 750°F and cooled very slowly. Heating and cooling test data graphically identical
◇	Ibid.	52-70	528-1032	76% Al; 13.35% Si; 7.91% Cu; 0.74% Fe	Same as above	Normalized 1 hr. at 400°C, cooled slowly
▽	Ibid.	52-70	402-1032	75.66% Al; 10.23% Si; 9.78% Cu; 3.91% Ni; 0.42% Fe	Same as above	Same as above
○	Ibid.	52-70	402-1032	74.5% Al; 20.29% Si; 3.18% Cu; 1.07% Mn; 0.96% Fe	Same as above	Same as above
○	Ibid.	52-70	402-1032	73.69% Al; 13.19% Si; 8.02% Cu; 4.10% Ni; 0.80% Fe	Same as above	Same as above
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	672-1032	Al Alloy RAE SA1 (British desig.) 11.0% Si; 5.0% Cu; 0.6% Mg; <0.5% Fe; 0.2% Co; 0.05% Ti	Quartz tube dilatometer in constant temp. bath	Wrought, heated 3 hr. at 500°C, cold water quenched, aged 16 hr. at 165°C, air cooled
□	Ibid.	49-54	672-1032	Same as above	Same as above	Chill cast, same as above
▽	Ibid.	49-54	672-1032	Al Alloy RAE SA 44 (British desig.) 11.0% Si; 5.0% Cu; 0.5% Mg; <0.5% Fe; 0.4% Mn; 0.3% Co; 0.1% Ti	Same as above	Wrought, same as above
△	Ibid.	49-54	672-1032	Same as above	Same as above	Chill cast, same as above
◇	Ibid.	49-54	672-1032	Al Alloy Lo-Ex (British desig.) 11.80% Si; 1.03% Cu; 1.02% Ni; 0.91% Mg; 0.50% Fe; 0.03% Mn; 0.02% Ti	Same as above	Wrought, heated 12 hr. at 520°C, quenched, aged 4 hr. at 135°C, air cooled, aged 4 hr. at 200°C, air cooled

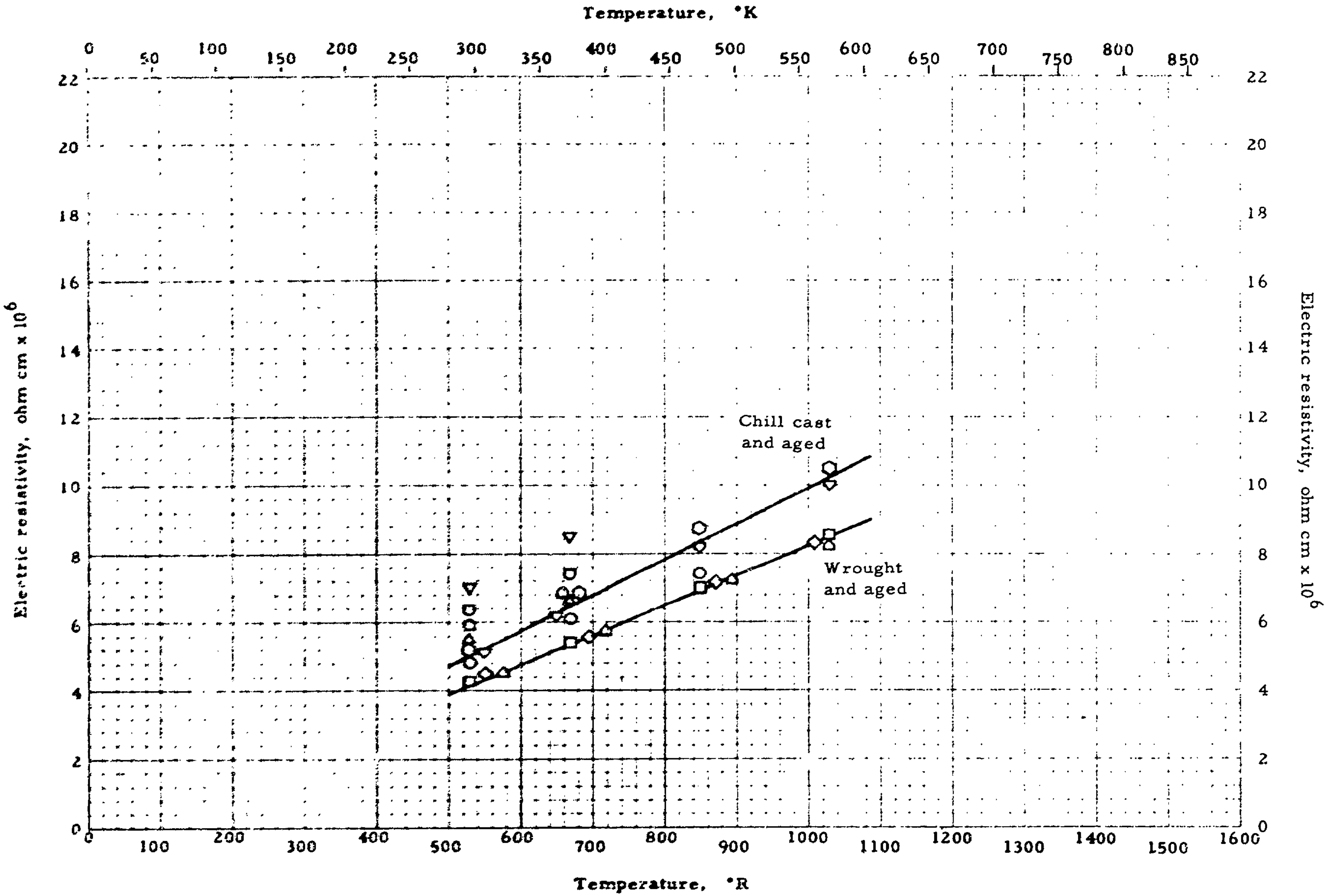


ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + COPPER + X
(2 - 6% Si; 1 - 3% Cu)

ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + COPPER + X
(2 - 6% Si; 1 - 3% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bollenrath, F. and Hauk, V.	48-1	528-1392	6.04% Si; 1.05% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Kelvin double bridge	Cast; held 6 hr. at 970°F and quenched in water
□	Ibid.	48-1	528-1212	5.00% Si; 1.03% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
△	Ibid.	48-1	528-1122	4.00% Si; 3.16% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
◇	Ibid.	48-1	528-1392	3.95% Si; 1.04% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
▽	Ibid.	48-1	528-1392	3.91% Si; 2.02% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
○	Ibid.	48-1	528-1392	3.06% Si; 1.04% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
□	Ibid.	48-1	528-1392	3.06% Si; 3.05% Cu; 0.15% Fe; 0.05% Zn; 0.02% Ti; Traces of Mg and Mn	Same as above	Same as above
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Aluminum alloy RR50 (British desig.): 2.25% Si; 1.40% Cu; 1.18% Fe; 0.90% Ni; 0.19% Ti; 0.12% Mg	Potential drop	Cast, heated 10 hr. at 165°C air cooled
□	Ibid.	49-54	528	Same as above	Same as above	Cast
▽	Ibid.	49-54	528-852	Aluminum alloy RR53C (British designation): 2.42% Si; 1.33% Cu; 1.12% Fe; 0.87% Ni; 0.50% Mg; 0.15% Ti	Same as above	Cast
◺	Ibid.	49-54	528-1032	Same as above	Same as above	Cast, heated 2 hr. at 530°C, water quenched, heated 15 hr. at 165°C

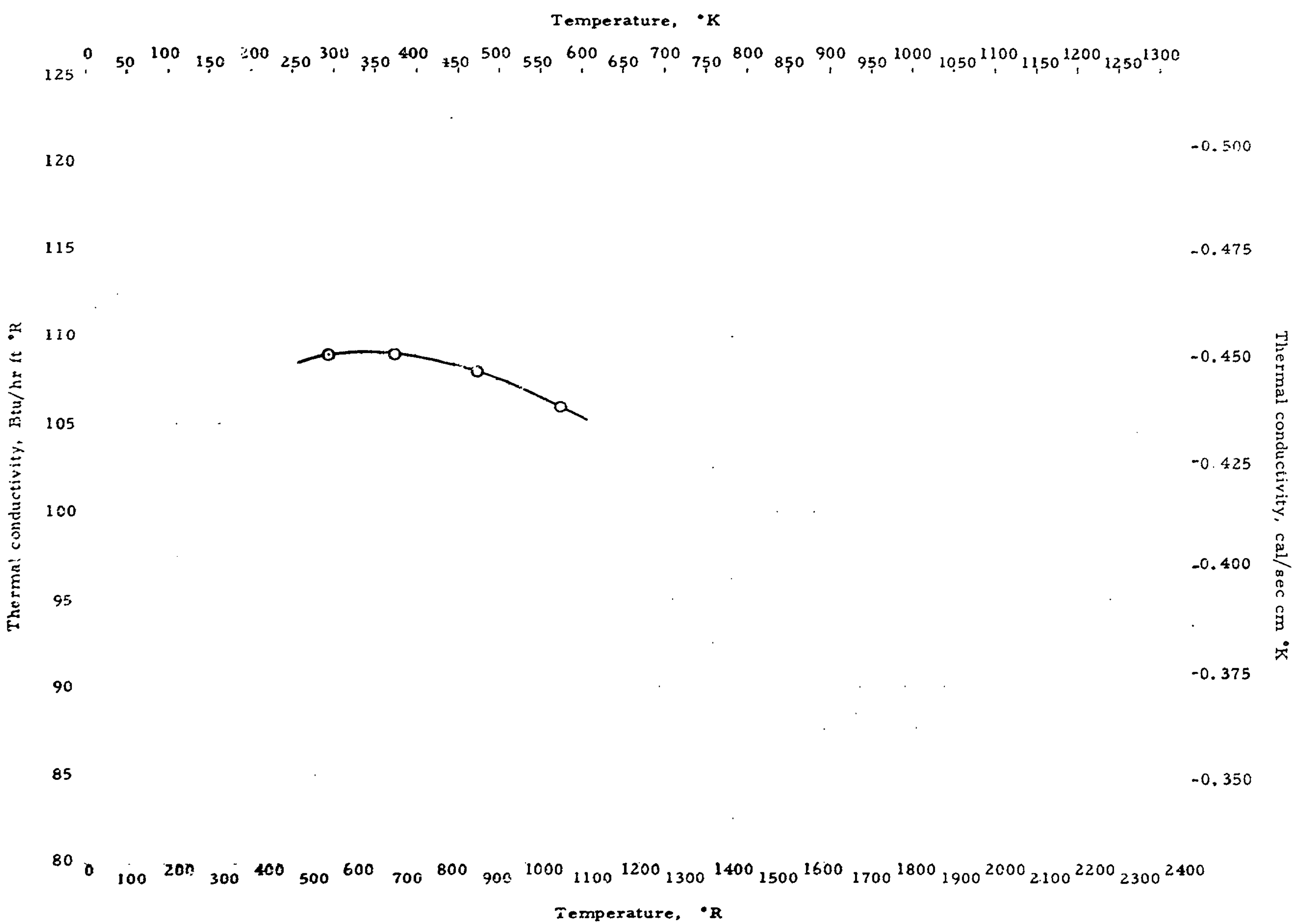


ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + COPPER + X
(11-12% Si; 1-5% Cu)

ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + COPPER + X
(11-12 % Si; 1-5% Cu)

REFERENCE INFORMATION

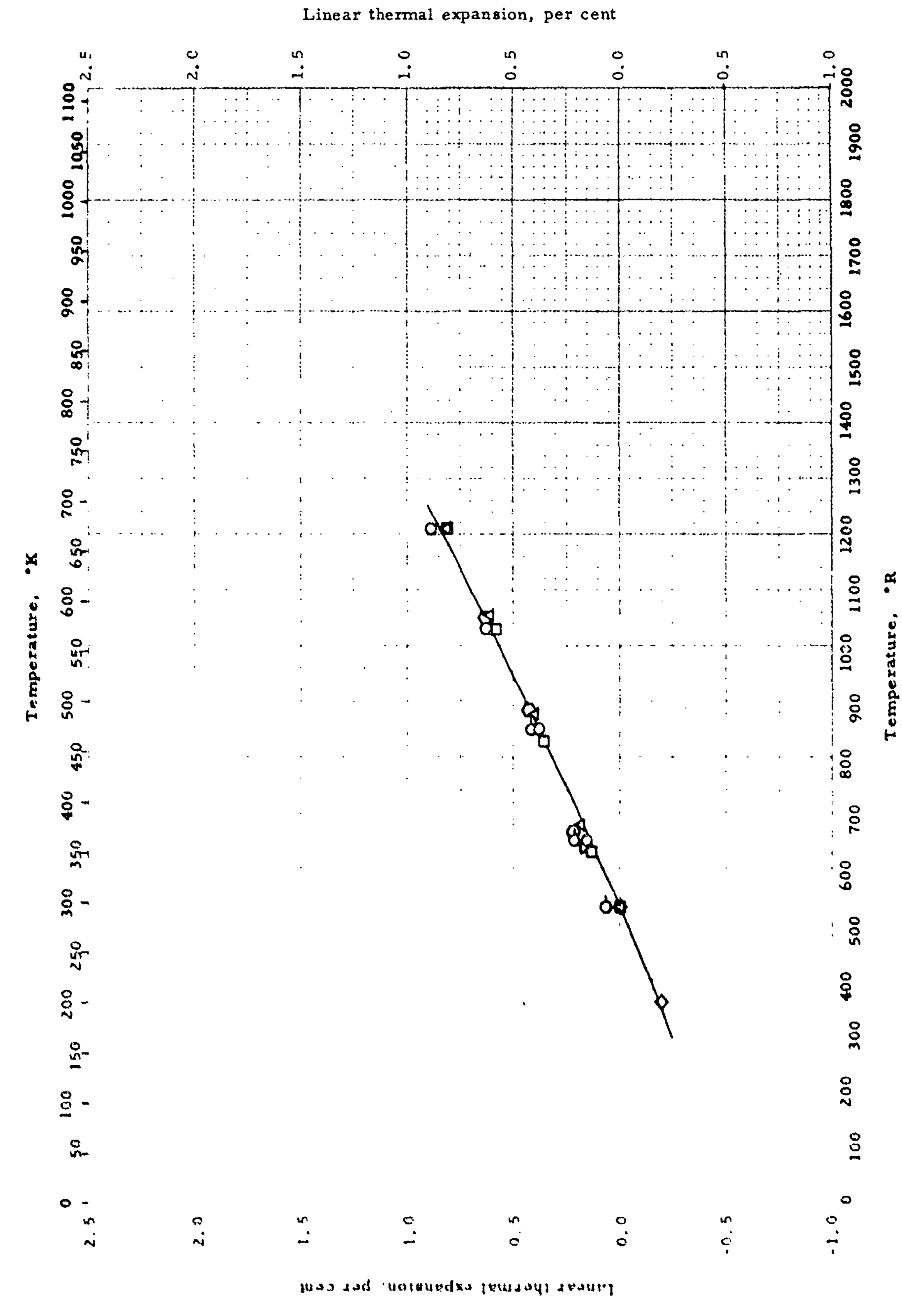
Sym bol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	43-54	528-852	Al Alloy Lo-Ex (British desig.). 11.80% Si; [illegible]% Cu, [illegible]% Ni, 0.91% Mg, 0.50% Fe, 0.03% Mn, 0.02% Ti	Potential drop	Wrought
□	Ibid.	43-54	528-1032	Same as above	Same as above	Wrought. Heated 12 hr. at 520°C, quenched, aged 4 hr. at 135°C, cooled in air, aged 4 hr. at 200°C, air cooled
△	Ibid.	43-54	528-672	Al Alloy RAE 5A44 (British desig.) [illegible]% Si, 5.0% Cu; 0.5% Mg, < 0.5% Fe; 0.4% Mn; 0.3% Co, 0.1% Ti	Same as above	Wrought. Auth. report a range of values of ± 4% for different samples
◇	Ibid.	43-54	528-1032	Same as above	Same as above	Wrought. Heated 3 hr. at 500°C, cold-water quenched, aged 16 hr. at 165°C, air cooled. Range of values ± 4% for different samples.
▽	Ibid.	43-54	528-672	Same as above	Same as above	Chill cast. Auth. report Range of values ± 7% for different samples.
○	Ibid.	43-54	528-1032	Same as above	Same as above	Chill cast. Heated 3 hr. at 500°C, cold-water quenched, aged 16 hr. at 165°C. Auth report a range of values ± 7% for different samples.
□	Ibid.	43-54	528-672	Al Alloy RAE 5A (British desig.) [illegible]% Si, [illegible]% Cu, 0.6% Mg; < 0.5% Fe; 0.2% Co; 0.05% Ti	Same as above	Wrought. Auth. report a range of values ± 7% for different samples.
△	Ibid.	43-54	528-1032	Same as above	Same as above	Wrought. Heated 3 hr. at 500°C, cold-water quenched, aged 16 hr. at 165°C, air cooled. Auth. report a range of values ± 7% for different samples.
□	Ibid.	43-54	528-672	Same as above	Same as above	Chill cast. Range of values ± 7 for different samples.
▽	Ibid.	43-54	528-672	Same as above	Same as above	Chill cast. Heated 3 hr. at 500°C, cold-water quenched, aged 16 hr. at 165°C. Auth. report a range of values ± 7% for different samples.



THERMAL CONDUCTIVITY -- ALUMINUM + SILICON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, R. W., Hickman, M.J. and Barber, C.R.	49-54	528-1032	Aluminum Alloy Alpax Gamma, British desig.: 12.0% Si; 0.35% Mg; 0.29% Mn; 0.28% Fe	Comparative; rods with heated guard tube. Temp. gradients by Nichrome-Const. thermocouple	4 hrs. at 510-518°C, cold water quenched; 16 hr. at 150-165°C

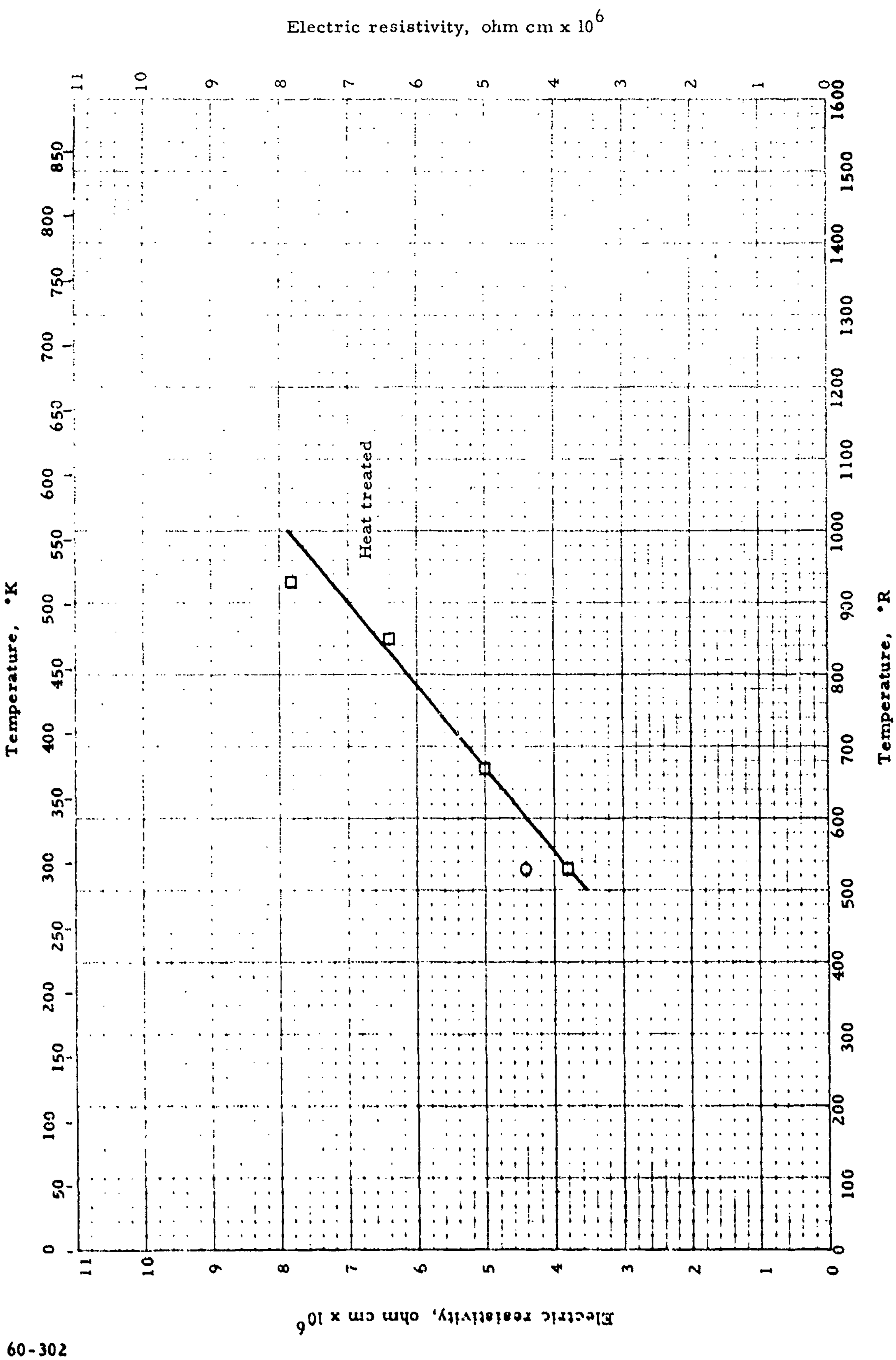


LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + MAGNESIUM + X

LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Krider, H. S.	52-70	528-1212	84.40% Al; 12.18% Si; 1.20% Mg; 0.89% Cu; 0.87% Ni; 0.41% Fe; 0.02% Zn; 0.01% Mn; 0.01% Cr; 0.01% Ti	Telemicroscopes sighting on wires suspended from sample	Solution heat treated 1 hr. at 960 °F; water quenched; aged at 340°F ○ heating; ○-cooling
□	Ibid.	52-70	528-1212	Same as above	Same as above	Same as above; then aged 100 hr. at 700°F; heating and cooling curves graphically identical
△	Ibid.	52-70	528-1212	Same as above	Same as above	Same as above; but aged 500 hr. at 800°F; heating and cooling curves graphically identical
◇	Perry, S.	45-6	360-528	Al alloy 356T4; 92.7% Al; 7% Si; 0.3% Mg	Quartz tube dilatometer	Solution heat treated 12 hr. at 1000°F; water cooled (150-210°F) and naturally aged to stable condition. Auth. est. accuracy ±3.4%
▽	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-672	Al Alloy Alpax gamma (British designation) 12.0% Si; 0.35% Mg; 0.29% Mn; 0.28% Fe	Quartz tube dilatometer, in constant temp. bath	Cast
○	Ibid.	49-54	528-1032	Same as above	Same as above	Cast, heated 4 hr. at 510-518°C, cold water quenched, heated 16 hr. at 150-166°C

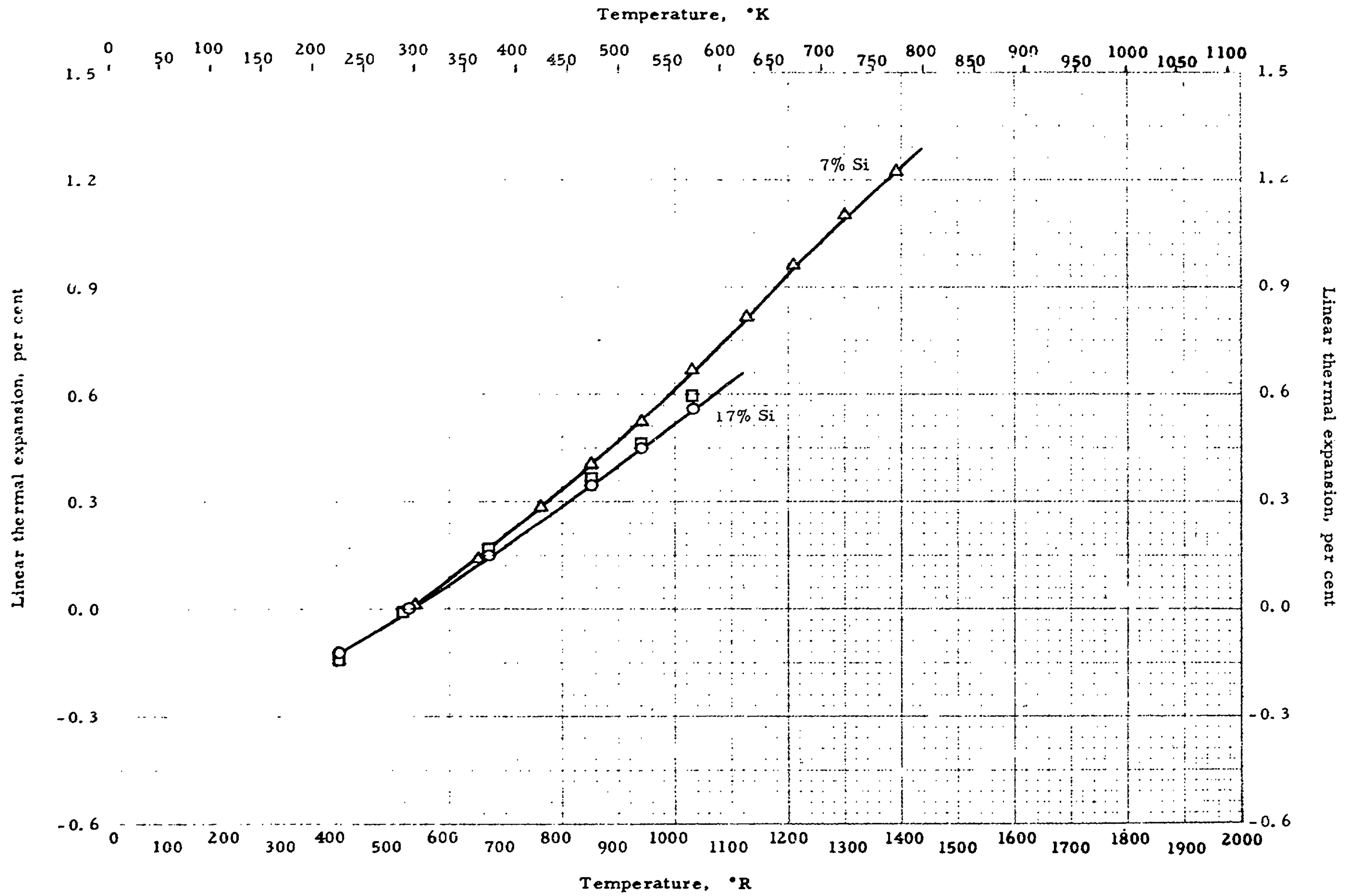


ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + MAGNESIUM + X

ELECTRIC RESISTIVITY -- ALUMINUM + SILICON + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528	Al alloy Alpax Gamma (British designation): 12.0% Si; 0.35% Mg; 0.29% Mn; 0.28% Fe	Potential drop	Cast, as received
□	Ibid.	49-54	528-1032	Same as above	Same as above	Cast, held 4 hr. at 515°C, cold water quenched, held 16 hr. at 150-165°C

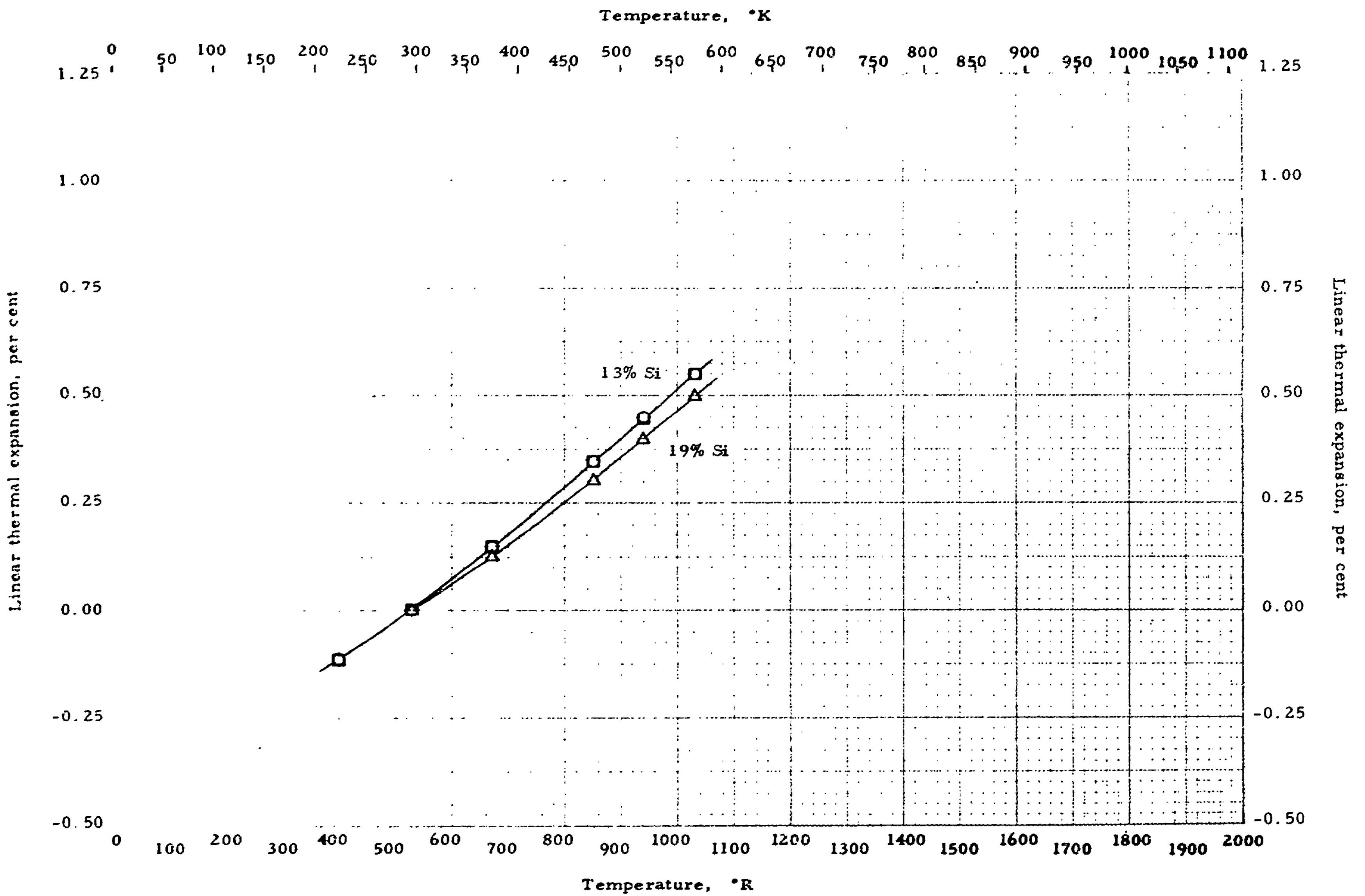


LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + IRON + X

LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + IRON + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Krider, H. S.	52-70	402-1032	81.80% Al; 17.27% Si; 0.81% Fe; 0.12% Cu	Above 528°R - telemicroscopes sighting on wires suspended from sample. Below 528°R - fused quartz tube dilatometer	Normalized 1 hr at 400°C, cooled slowly.
□	Ibid	52-70	402-1032	86.01% Al; 13.08% Si; 0.76% Fe; 0.15% Cu	Same as above	Same as above
△	Bollenrath, F. and Hauk, V.	48-1	528-1392	7.10% Si; 0.15% Fe; 0.05% Zn; 0.02% Ti; 0.01% Cu; Trace Mg, Mn	Leitz quartz tube dilatometer	Cast, held 6 hr at 520°C and checked in water



LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + NICKEL + X

LINEAR THERMAL EXPANSION -- ALUMINUM + SILICON + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hidnert, P. and Krider, H. S.	52-70	402-1032	77.83% Al; 13.22% Si; 4.12% Ni; 4.05% Cu; 0.78% Fe	Below 528°R - fused quartz tube dilatometer. Above 528°F - tele-microscopes sighting on wires suspended from sample	Normalized 1 hr. at 400°C, cooled slowly
□	Ibid.	52-70	402-1032	76.59% Al; 12.68% Si; 4.44% Ni; 4.13% Cu; 1.36% Mo; 0.80% Fe	Same as above	Same as above
△	Ibid.	52-70	402-1032	71.46% Al; 19.30% Si; 4.18% Ni; 3.14% Cu; 1.08% Mn; 0.84% Fe	Same as above	Same as above

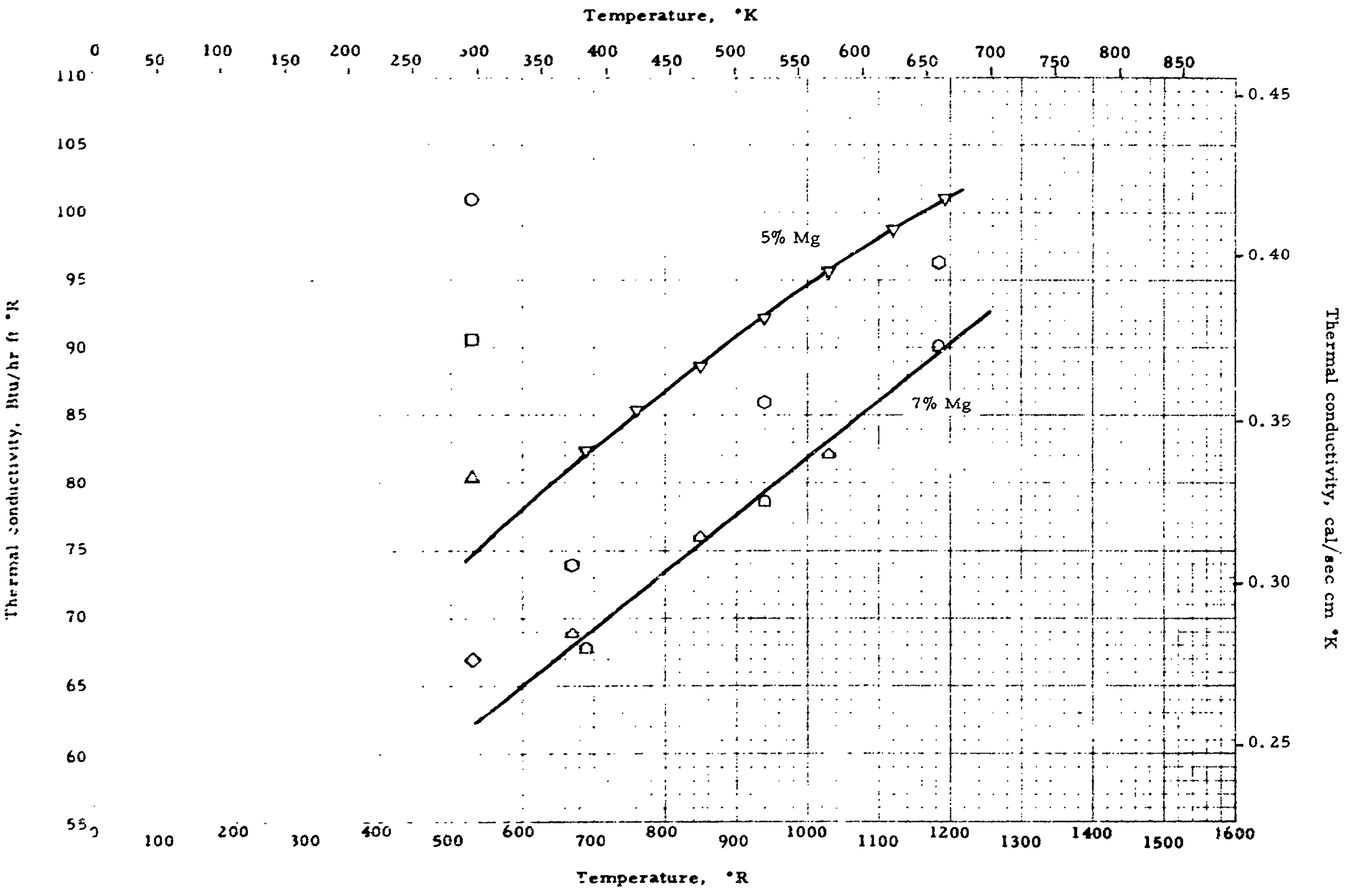
Symbol	Composition			Density		Melting Point	
	Al	Mg	Mn	lb_m/ft^3	g/cm^3	°R	°K
O	98.2	1.5	0.3	169	2.7	1608	893
	97.2	2.5	0.3	167	2.68	1590	883
	96.1	3.5	0.4	167	2.67	1554	863
	94.6	5	0.4	165	2.65	1527	848

PROPERTIES OF ALUMINUM + MAGNESIUM + X

PROPERTIES OF ALUMINUM + MAGNESIUM + X

REFERENCE INFORMATION

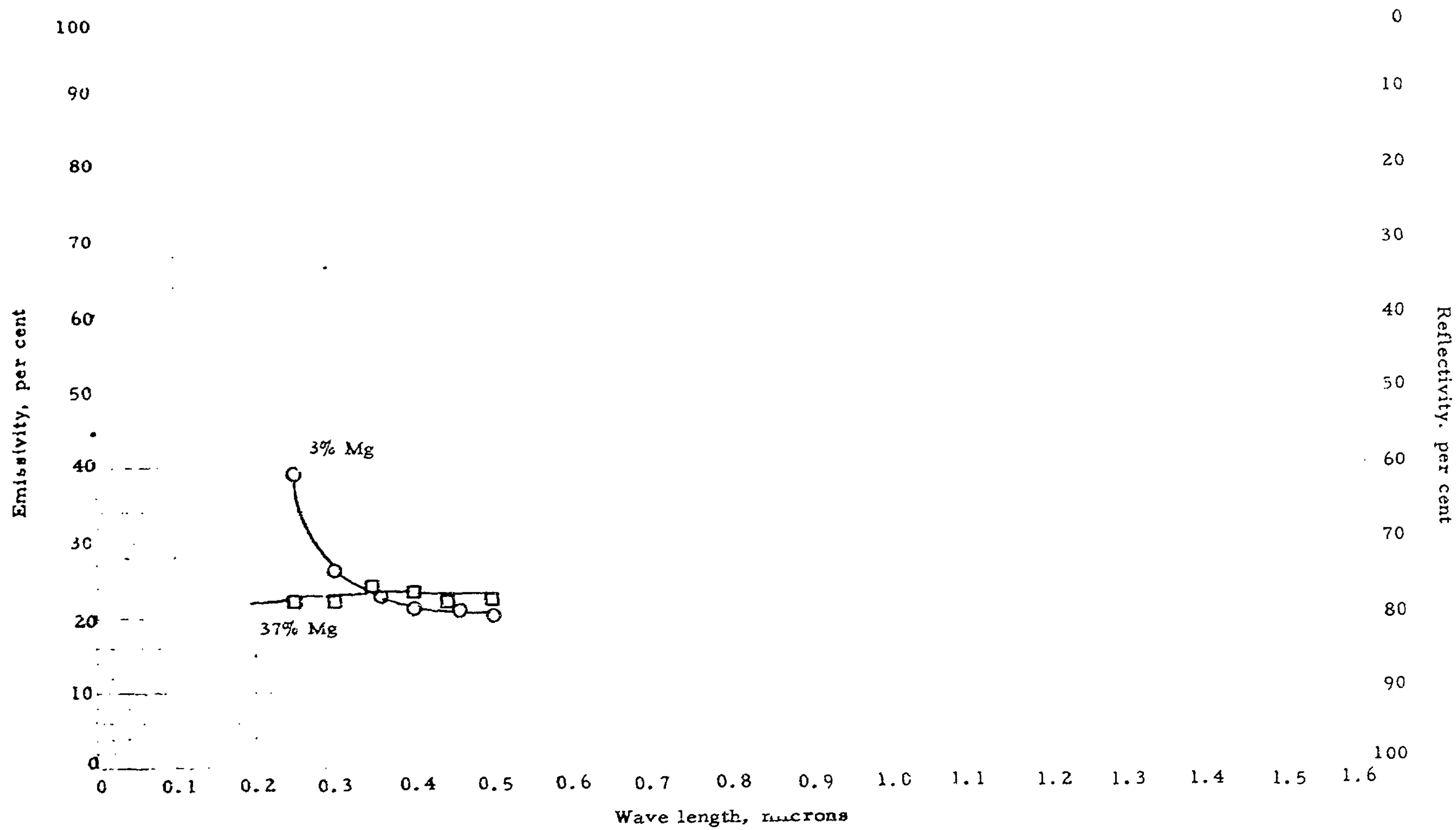
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Anon.	55-46	528 1527-1608	Recidal alloy series; 98.2-94.6% Al; 1.5-5% Mg; 0.3-0.4% Mn	ρ: not given MP: not given	Held at 1180°R for 2-6 hours for complete softening; free cutting high strength alloy



THERMAL CONDUCTIVITY -- ALUMINUM + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Anonymous	55-46	room	98.2% Al; 1.5% Mg; 0.3% Mn; ρ = 169 lb_m/ft^3	Not given	Held 2-6 hr. at 360-400°C
□	Ibid.	55-46	room	97.2% Al; 2.5% Mg; 0.3% Mn; ρ = 167 lb_m/ft^3	Same as above	Same as above
△	Ibid.	55-46	room	96.1% Al; 3.5% Mg; 0.4% Mn; ρ = 167 lb_m/ft^3	Same as above	Same as above
◇	Ibid.	55-46	room	94.6% Al; 5% Mg; 0.4% Mn; ρ = 165 lb_m/ft^3	Same as above	Held at 330-370°C and slowly cooled
▽	Hase, R., Heierberg, R. and Walkenhorst, W.	40-16	670-1190	Hydronalium 5 (German desig.). Nominal: 95% Al; 5% Mg	Temp. distribution along resistance heated rod Temp. meas. by thermocouple. Tested in vac.	Cast at 700°C into molds at 200°C, rolled and drawn, then turned into rods. Radiation less than 5%
○	Ibid.	40-16	670-1190	Hydronalium 51 (German desig.). Nominal: 5% Mg, 0.2-1.5% Si; 0.2-0.5% Mn	Same as above	Same as above
○	Ibid.	40-16	670-1190	Hydronalium 7 (German desig.) Nominal: 92.5% Al; 7% Mg, 0.5% Mn	Same as above	Same as above
○	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	528-1032	Al alloy. RR 131D (British desig.), 1.39% Mg; 1.20% Ni; 0.50% Si; 0.45% Zn, 0.44% Mn; 0.30% ea. Cu, Fe; 0.25% Co; 0.18% Cr; 0.12% Ti	Comparative; rods, with heated guard tube. Temp gradient by Nichrome-Constantan thermocouples	Cast

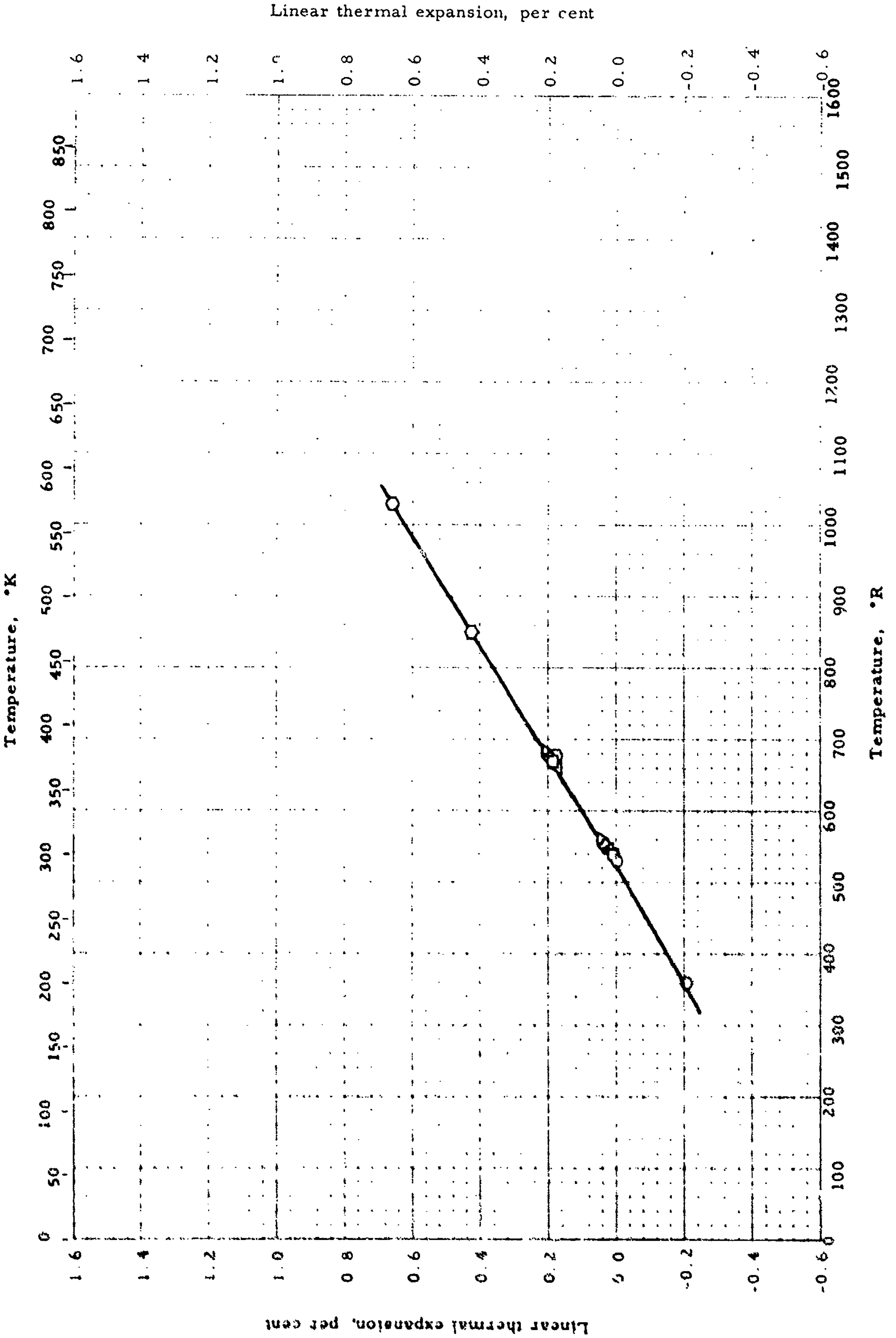


SPECTRAL EMISSIVITY -- ALUMINUM + MAGNESIUM

SPECTRAL EMISSIVITY -- ALUMINUM + MAGNESIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Boettcher, A.	50-28	Room	3.0% Mg	Spectral reflectivity at 45°; intensity of direct U. V. light and that reflected at 45° compared on photographic plate	Evaporated metal layers heat treated after deposit to ensure complete alloying
□	Ibid.	50-28	Room	37.0% Mg	Same as above	Same as above

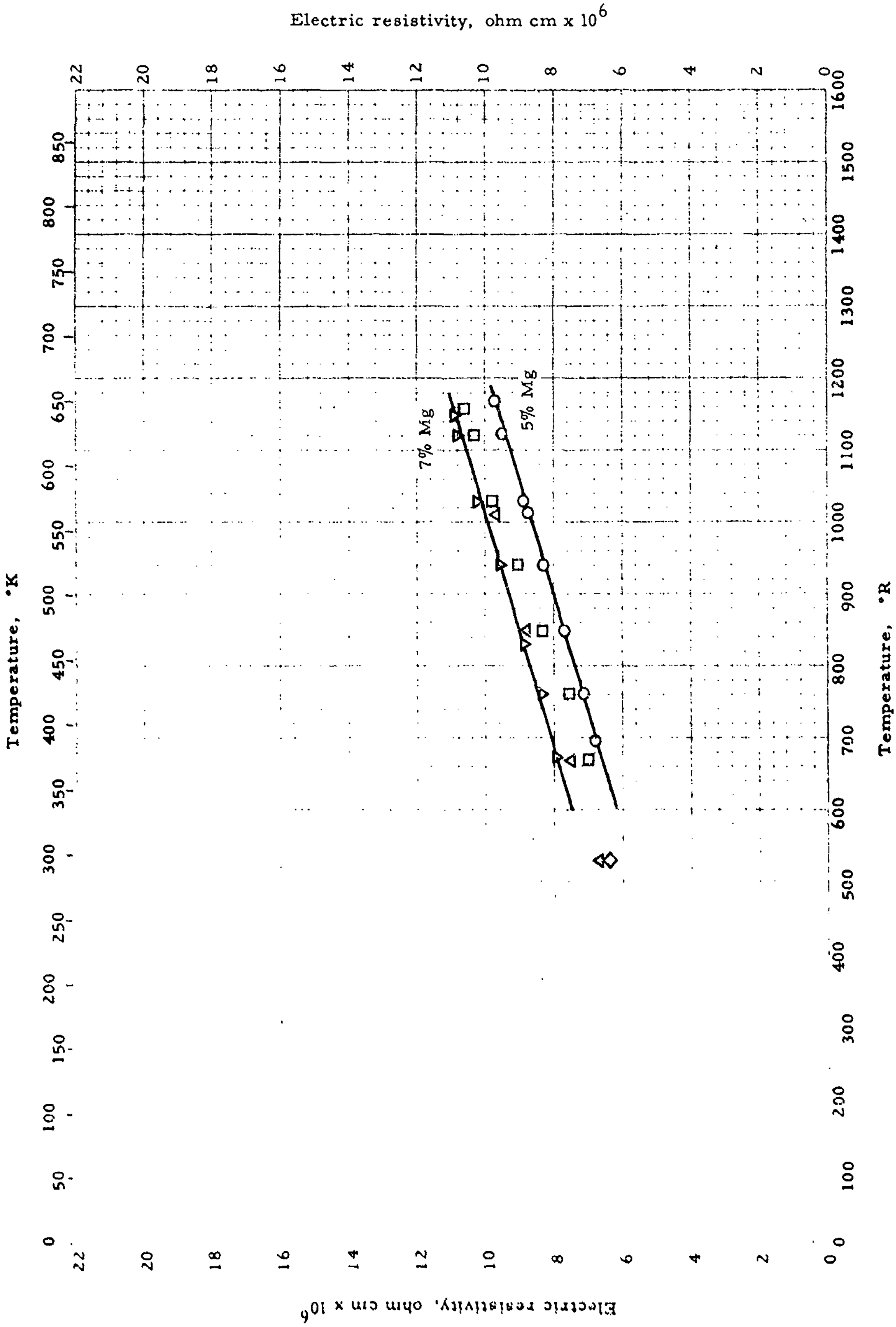


LINEAR THERMAL EXPANSION -- ALUMINUM + MAGNESIUM + X

LINEAR THERMAL EXPANSION -- ALUMINUM + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Perry, S.	45-6	360-528	Al alloy 220T4: 90% Al; 10% Mg	Dilatometer	Solution heat treated, naturally aged to a substantially stable condition. Auth. est. accuracy ± 3.4%
□	Anonymous	55-46	528-672	94.6% Al; 5.0% Mg; 0.4% Mn. ρ = 165 lb_m/ft^3	Not given	Held at 330-370°C for max. softening; cooled slowly to 250°C
△	Ibid.	55-46	528-672	96.1% Al, 3.5% Mg; 0.4% Mn. ρ = 167 lb_m/ft^3	Same as above	Held 2-6 hr. at 360-400 °C for complete softening
◇	Ibid.	55-46	528-672	97.2% Al; 2.5% Mg; 0.3% Mn. ρ = 168 lb_m/ft^3	Same as above	Same as above
▽	Ibid.	55-46	528-672	98.2% Al, 1.5% Mg; 0.3% Mn. ρ = 169 lb_m/ft^3	Same as above	Same as above
○	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	672-1032	Al Alloy RR 131D (British desig.): 1.39% Mg; 1.20% Ni; 0.50% Si; 0.45% Zn; 0.44% Mn; 0.30% ea. Cu, Fe; 0.25% Co; 0.18% Cr; 0.12% Ti	Quartz tube dilatometer in constant temp. bath	Cast, held 10 hr. at 160°C-170°C, air cooled



ELECTRIC RESISTIVITY -- ALUMINUM + MAGNESIUM + X

ELECTRIC RESISTIVITY -- ALUMINUM + MAGNESIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hase, R., Heierberg, R. and Walkenhorst, W.	40-16	698-1168	Hydronalium 5 (German desig.): nominal: 95% Al; 5% Mg	Potential drop, thermocouple	Cast at 700 °C into molds at 200 °C, rolled and drawn, then turned into rods
□	Ibid.	40-16	672-1158	Hydronalium 51 (German desig.): nominal: 5 - 12% Mg; 0.2 - 1.5% Si; 0.2 - 0.5% Mn	Same as above	Same as above
▽	Ibid.	40-16	675-1148	Hydronalium 7 (German desig.): nominal: 7% Mg; 0.45% Mn	Same as above	Same as above
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Al Alloy RR131D (British desig.): 1.39% Mg; 1.20% Ni; 0.50% Si; 0.45% Zn; 0.44% Mn; 0.30% ea. Cu, Fe; 0.25% Co; 0.18% Cr; 0.12% Ti	Potential drop	Cast, as received
◇	Ibid.	49-54	528	Same as above	Same as above	Cast, heated 10 hr. at 160-170 °C, air cooled

PROPERTIES OF ALUMINUM + ZINC + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	175 lb_m/ft^3 *	2.80 g/cm^3 *
Melting Point	2030°R *	870°K *
Heat of Fusion	167 Btu/lb_m *	93 cal/g *
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Values for alloy L'A-Z5G.

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	○	174.9	2.801
	□	175	2.80

Melting Point:		°R	°K
	□	2032	873

Heat of Fusion:		Btu/lb_m	cal/g
	□	167	93

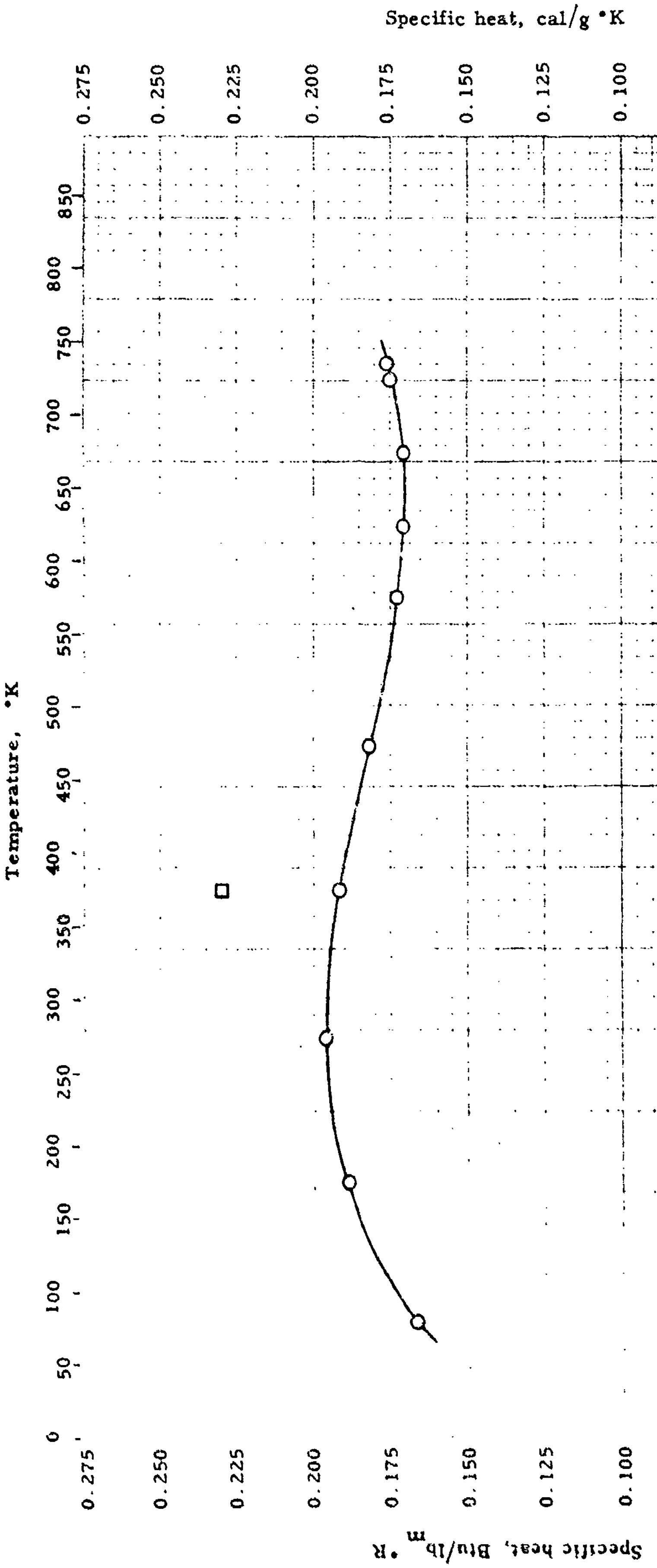
Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5 51-65	528	Alloy 7075-T6; nominal: 5.6% Zn; 2.5% Mg; 1.6% Cu; 0.3% Cr	ρ: weight and vol. by water displacement	
□	Roinet, C.	56-53	Room 2032 2032	French alloy L'A-Z5G; nominal: 4.5-5.5% Zn; 0.4-0.65% Mg; 0.15-0.35% ea. Cu, Cr; 0.15-0.25% Ti; <0.8% Fe; <0.4% Mn; <0.3% Si; <0.05% Ni	ρ: not given MP: not given Δh_f: not given	Tested by Research Dept. of Pechiney at Chambery. Casting alloy, fully aged

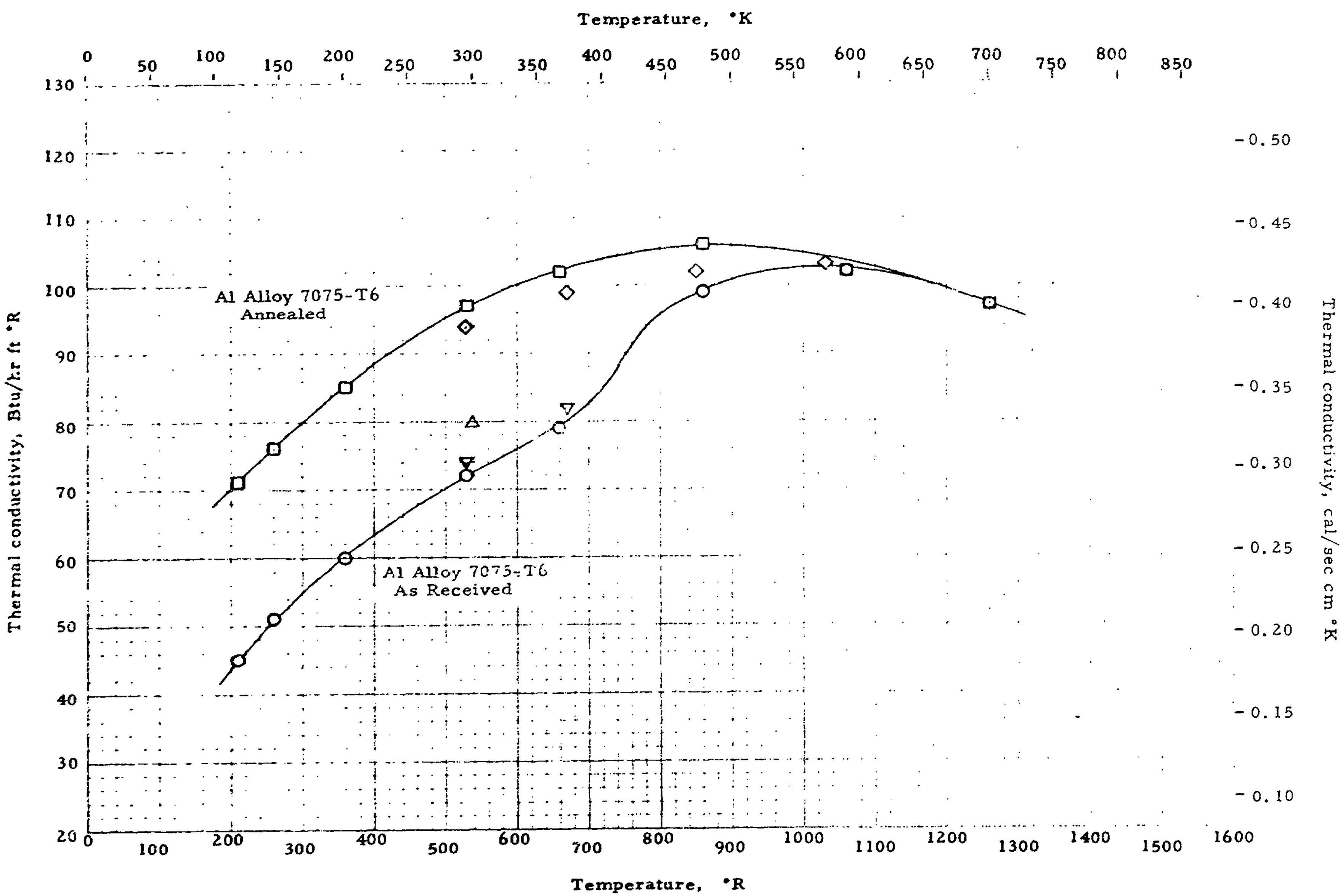


SPECIFIC HEAT -- ALUMINUM + ZINC + X

SPECIFIC HEAT -- ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F., Matolich, J. and Van Valzor, J. A.	54-27 also 58-5	140-1325	Al Alloy 75S-T6; 90% Al; 5.5% Zn; 2.5% Mg; 1.5% Cu; 0.3% Cr; 0.2% Mn	Drop method; ice calorimeter	
□	Roinet, C.	56-53	672	Alloy L'A-Z5G (French Desig.); 4.5-5.5% Zn; 0.4-0.65% Mg; 0.15-0.35% ea. Cu, Cr; 0.15-0.25% Ti; < 0.8% Fe; < 0.4% Mn; < 0.3% Si. ρ = 175 lb_m/ft^3	Not given	Fully aged

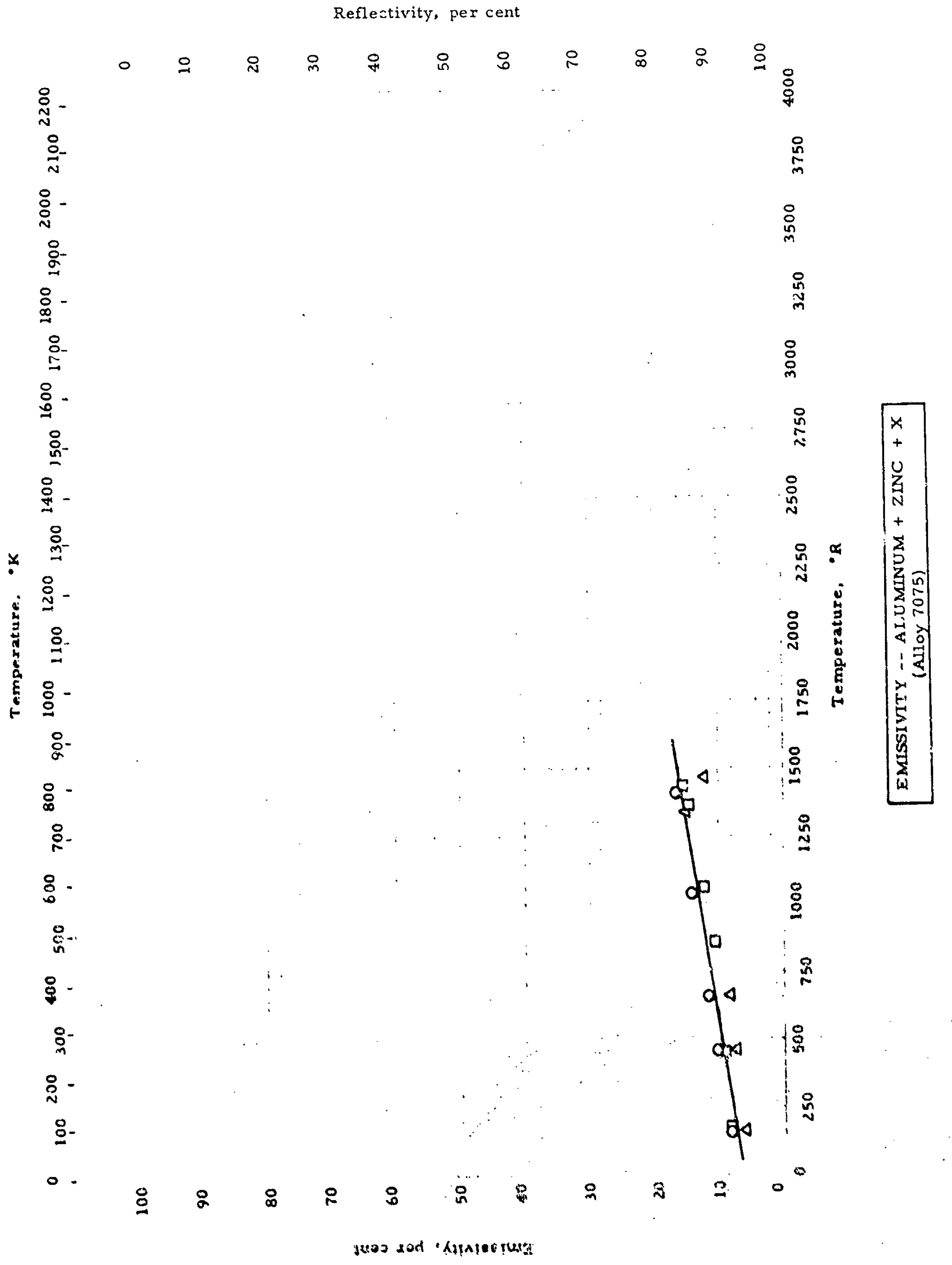


THERMAL CONDUCTIVITY -- ALUMINUM + ZINC + X

THERMAL CONDUCTIVITY -- ALUMINUM + ZINC + X

REFERENCE INFORMATION

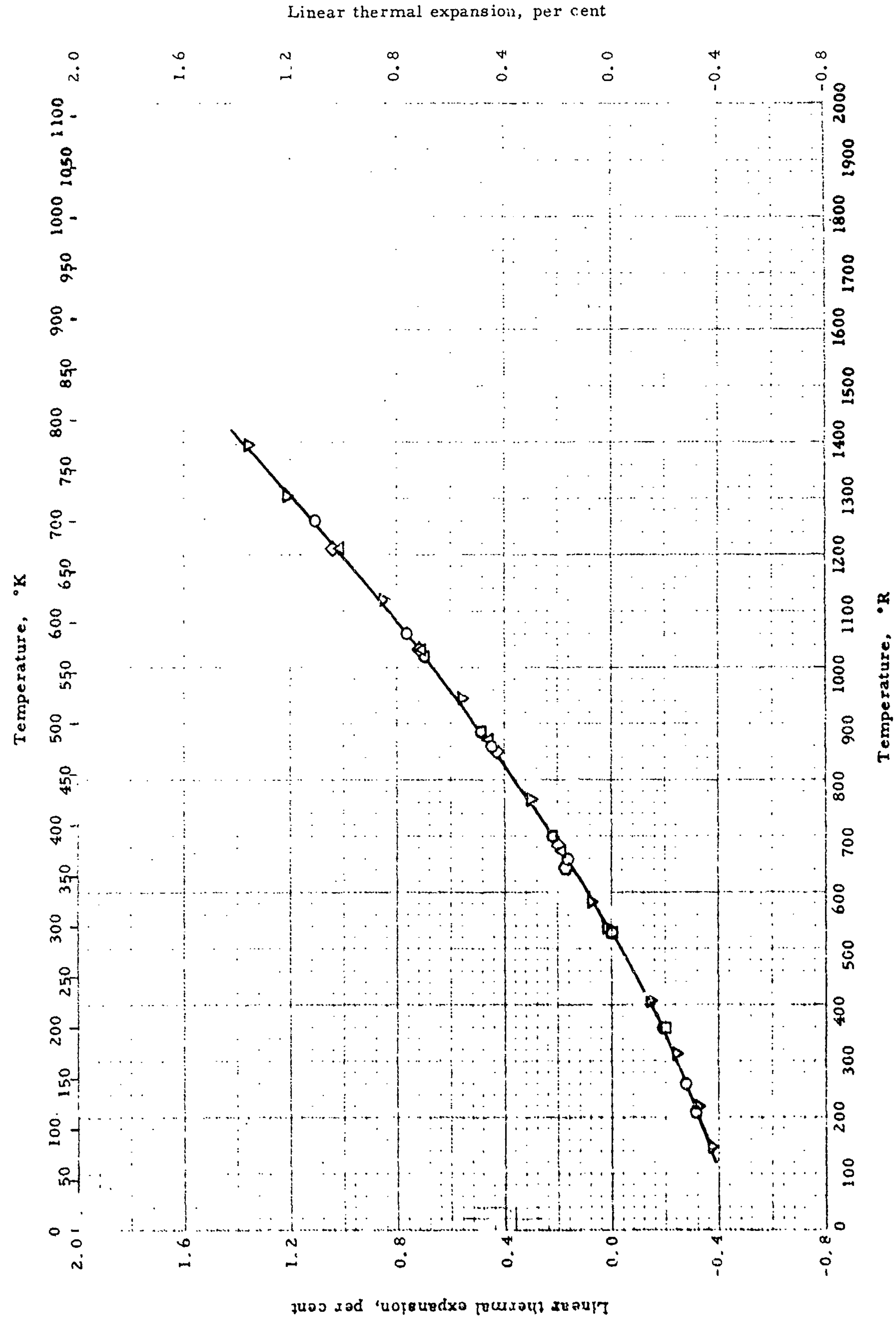
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5 51-65	10-1260	7075-T6 (Alcoa); 5.6% Zn; 2.5% Mg; 1.6% Cu; 0.3% Cr	Comparative, rods (Armco Iron standard)	As received ρ = 175 lb_m/ft^3
□	Ibid.	58-5	210-1260	Same as above	Same as above	After heating above 575°F
△	Roinet, C.	56-53	537	Alloy L'A-Z5G (French Desig.); 4.5-5.5% Zn; 0.4-0.65% Mg; 0.15-0.35% ea. Cu, Cr; 0.15-0.25% Ti; <0.8% Fe; < 0.4% Mn; <0.3% Si; <0.05% Ni; ρ = 175 lb_m/ft^3	Not given	Fully aged
◇	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	528-1032	Wrought alloy RR77 (British Designation); 4.96% Zn; 2.54% Mg; 2.20% Cu; 0.54% Mn; 0.31% Fe; 0.26% Si; Tr of Ti	Comparative; rods with heated guard tube. Temp. gradient by Nichrome-Constantan thermocouples	Solution heat treated 2 hrs at 450° C, quenched in water at 70° C, aged 4 hrs at 135° C, Aircooled
▽	Ibid	49-54	528-1032	Same as above	Same as above	As received


Reflectivity, per cent
Temperature, °K
Temperature, °R
Emissivity, per cent
EMISSIVITY -- ALUMINUM + ZINC + X
(Alloy 7075)

EMISSIVITY -- ALUMINUM + ZINC + X
(Alloy 7075)

REFERENCE INFORMATION

Symbol	Investigator	Ref	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G. B.	54-122	160-1459	Al Alloy 75ST. Nominal: 5.6% Zn; 2.5% Mg; 1.6% Cu; 0.3% Cr	Total normal emissivity: comparative: radiant heat flow compared with that of a black body. Tested in vac. of 10μ Hg	As received: wiped with toluene until clean, then with alcohol
□	Ibid.	54-122	160-1450	Same as above	Same as above	Clean and smooth: scrubbed with soap, washed with water, dried, wiped with toluene and then with alcohol
△	Ibid.	54-122	160-1450	Same as above	Same as above	Polished: buffed until mirror-like and free of scratches, washed with soap and dried

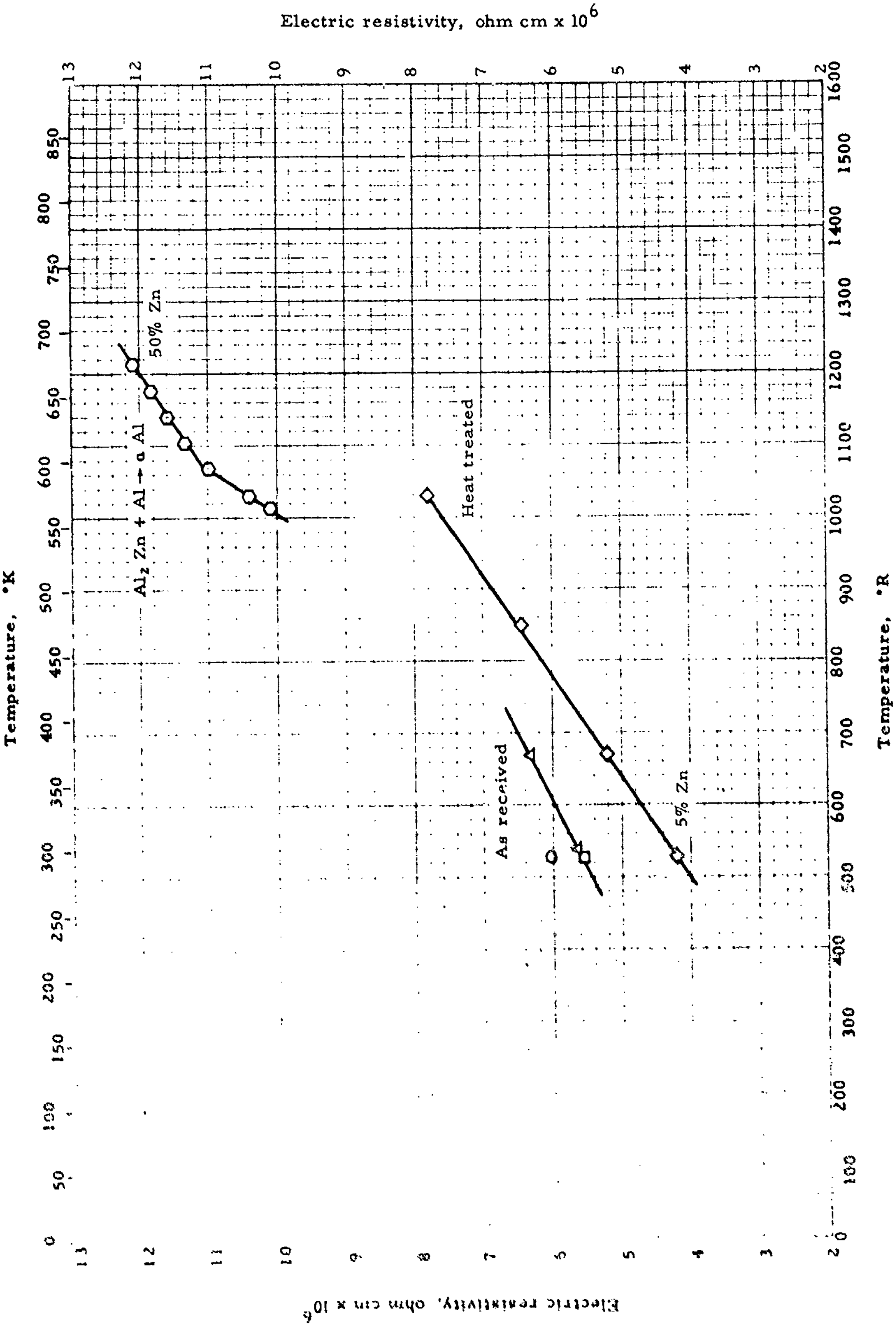


LINEAR THERMAL EXPANSION -- ALUMINUM + ZINC + X

LINEAR THERMAL EXPANSION -- ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H.W.	58-5	210-1260	Alloy 7075-T6 (Alcoa); nominal: 5.1-6.1 Zn; 2.1-2.9% Mg; 1.2-2.0% Cu; 0.7% Fe; 0.5% Si; X	Quartz tube dilatometer	Tested in vacuum
□	Perry, S.	45-6	360-528	Alloy 75ST (nominally same as 7075)	Quartz tube dilatometer	Auth. est. accuracy ± 3.4%
△	Rainet, C.	56-53	528-1212	Alloy No. L'A-Z5G; nominal: 4.5-5.5% Zn; 0.4-0.65% Mg; 0.15-0.35% ea. Cu, Cr; 0.15-0.25% Ti; <0.8% Fe; <0.4% Mn; <0.3% Si; <0.05% Ni. $\rho = 175\ lb_m/ft^3$	Not given	Cast, fully aged
◇	Ibid.	56-53	528-1212	Same as above	Same as above	Cast, normalized at 180°C
▽	Lucks, C.F., Thompson, H.B et al.	51-65	150-1392	Al Alloy 75S-T6: 5.6% Zn; 2.5% Mg; 1.6% Cu; 0.3% Cr. $\rho = 175\ lb_m/ft^3$	Quartz tube dilatometer	Tested at 1.5-2.5°C/min. rise in A atm.
○	Powell, R.W., Hickman, M.J. and Barber, C.R.	49-54	672	Alloy RR77 (British desig.) 4.96% Zn, 2.54% Mg; 2.20% Cu; 0.54% Mn; 0.31% Fe; 0.26% Si; trace Ti	Quartz tube dilatometer in constant temp. bath	Wrought
◻	Ibid.	49-54	672-1032	Same as above	Same as above	Wrought, 2 hr. solution heat treatment at 450°C, quenched in water at 70°C, aged 4 hr. at 135°C, air cooled

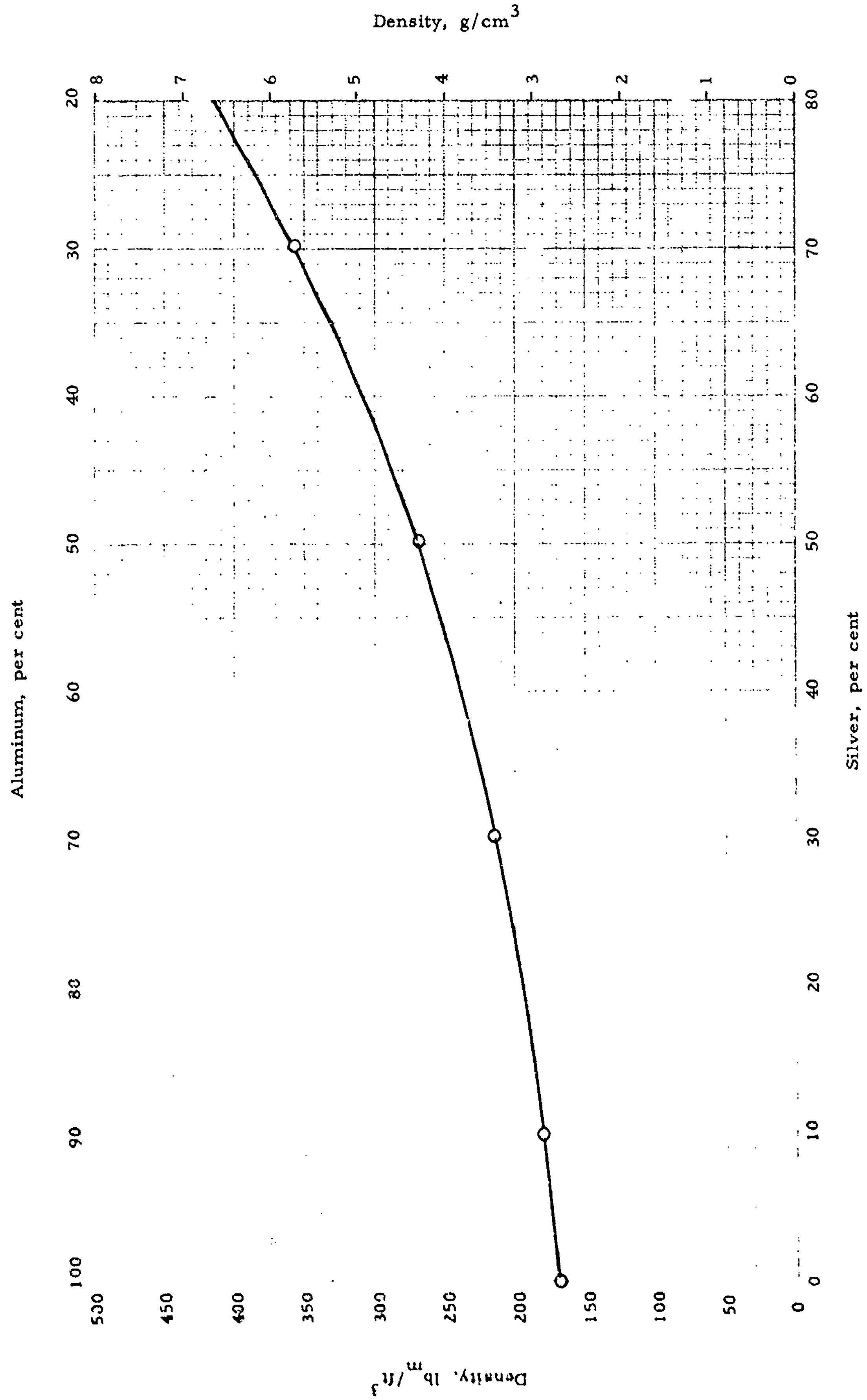


ELECTRIC RESISTIVITY -- ALUMINUM + ZINC + X

ELECTRIC RESISTIVITY -- ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Roinet, C.	56-53	528	Al-Zn alloy L'A - Z5G nominal: 4.5 - 5.5% Zn; <0.8% Fe; 0.4 - 0.65% Mg; <0.4% Mn; 0.15 - 0.35% ea. Cu, Cr; <0.3% Si; 0.15 - 0.25% Ti; <0.05% Ni $\rho = 175\ lb_m/ft^3$	Not given	Fully aged
□	Ibid.	56-53	528	Same as above	Not given	Normalized at 180°C
△	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-672	Al alloy RR77 (British designation): 4.96% Zn; 2.54% Mg; 2.20% Cu; 0.54% Mn; 0.31% Fe; 0.26% Si; trace of Ti	Potential drop	Wrought, as received
◇	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, solution heat treated 2 hr. at 450°C, quenched in water at 70°C, aged 4 hr. at 135°C, air cooled
⬡	Munster, A. and Sagel, K.	56-131	1014-1212	48.9% Zn	Automatically controlled resistance furnace	Made from Al with 0.002% Fe, 0.001% ea. Si, Cu, Mg; Zn with 0.002% ea. Fe, Pb, 0.001% ea. Cu, Mg, Cd Melted, pressed, wiredrawn, annealed 48 hr. at 370°C, held 2 hr. at 400°C



DENSITY -- ALUMINUM + SILVER

DENSITY -- ALUMINUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, H. and Evans, E. J.	43-4	Room	0 - 70% Ag	Weight in air and in water	Made from pure Ag and 99.99% pure Al

PROPERTIES OF ALUMINUM + SILVER

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	180 lb_m/ft^3 *	2.9 g/cm^3 *
Melting Point		
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .	$3400_{1460°R}$ Btu/lb_m *	$1890_{810°K}$ cal/g *

*Value for 10% Ag; for others, see Reported Values below.

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3	Nominal Composition, % Al	Ag
O	169	2.71	100	0
O	181	2.90	89.98	10.02
O	215	3.45	69.79	30.21
O	268	4.30	49.81	50.19

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

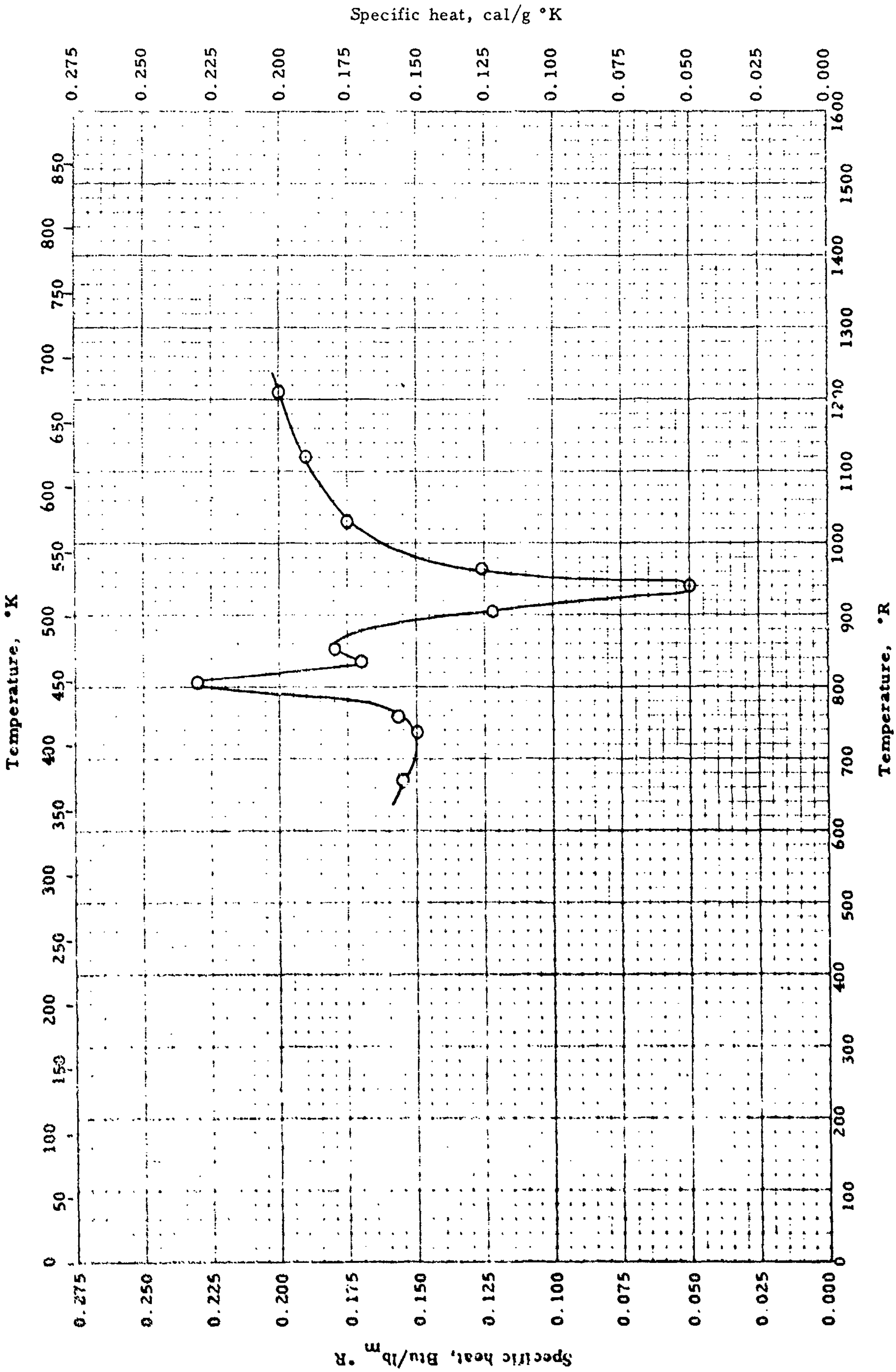
Heat of Sublimation:

	Btu/lb_m	cal/g	Nominal Composition, % Al	Ag
□	$3401_{1455°R}$	$1889_{810°K}$	90.4	9.6
△	$3353_{1505°R}$	$1863_{840°K}$	83.5	16.5

PROPERTIES OF ALUMINUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, H. and Evans, E. J.	43-4	Room	Alloy series: 0 - 50% Ag; prepared from pure Ag and 99.99% pure Al.	ρ: weight in air and water	
□	Finkelshtein, D. N. and Yamshchikova, A. I.	54-70	1374-1572	Nominal: 9.6% Ag	Δh_s: not described here, refer to others	Data reported as diffusion coefficient and its energy of activation
△	Ibid.	54-70	1374-1572	Nominal: 16.5% Ag	Δh_s: same as above	Same as above

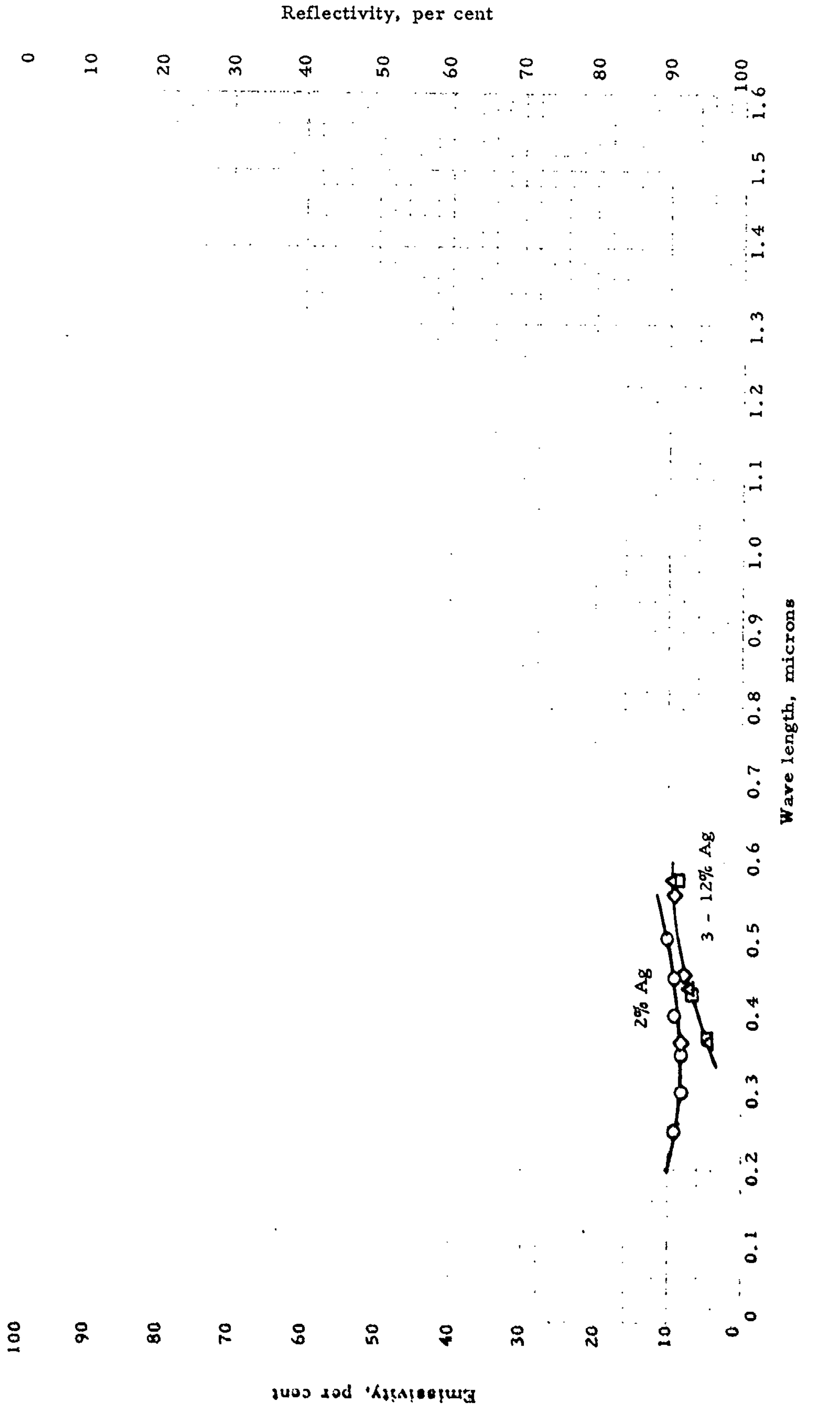


SPECIFIC HEAT -- ALUMINUM + SILVER

SPECIFIC HEAT -- ALUMINUM + SILVER

REFERENCE INFORMATION

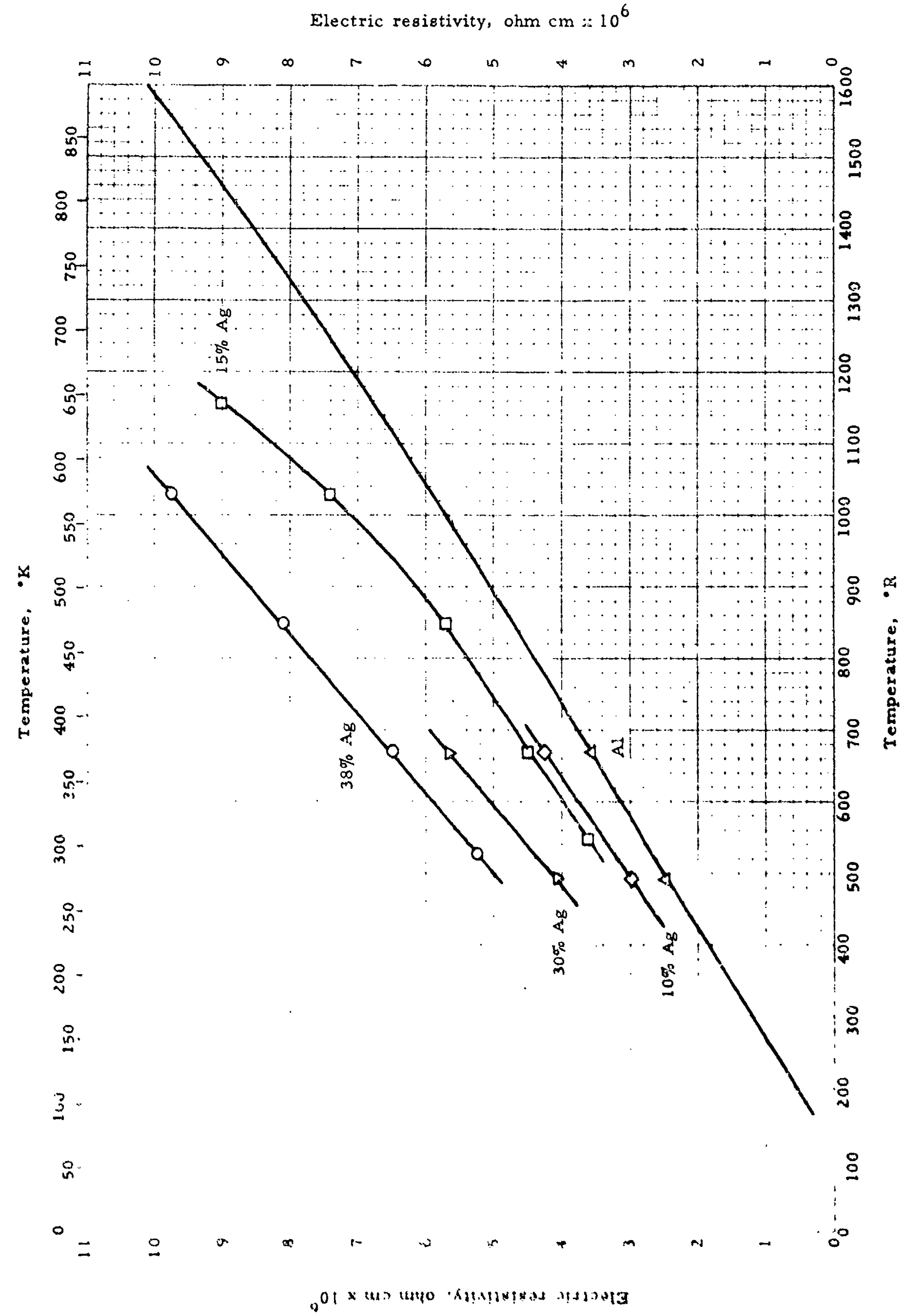
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Jones, F. W. and Leech, P.	41-14	672-1212	60% Al; 40% Ag	Temp. rise curve in resistance heated sample	Quenched from 550°C and aged 7 days at room temp. Shape of curve attributed to pre-precipitation phenomena



SPECTRAL EMISSIVITY -- ALUMINUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Boettcher, A.	50-28	Room	2.0% Ag; δ phase	Spectral reflectivity at 45°: intensity of direct U.V. light and that reflected at 45° compared on photographic plate	Evaporated metal layers, heat treated after deposit to ensure complete alloying
□	Krebs, K. and Winkler, R.	57-152	Room	97% Al; 3% Ag	Spectral reflectivity: Not described here, refers to others	Film evaporated in 1 min. at 10^{-5} atm. vac.
△	Ibid.	57-152	Room	91% Al; 9% Ag	Same as above	Same as above
◇	Ibid.	57-152	Room	88% Al; 12% Ag	Same as above	Same as above

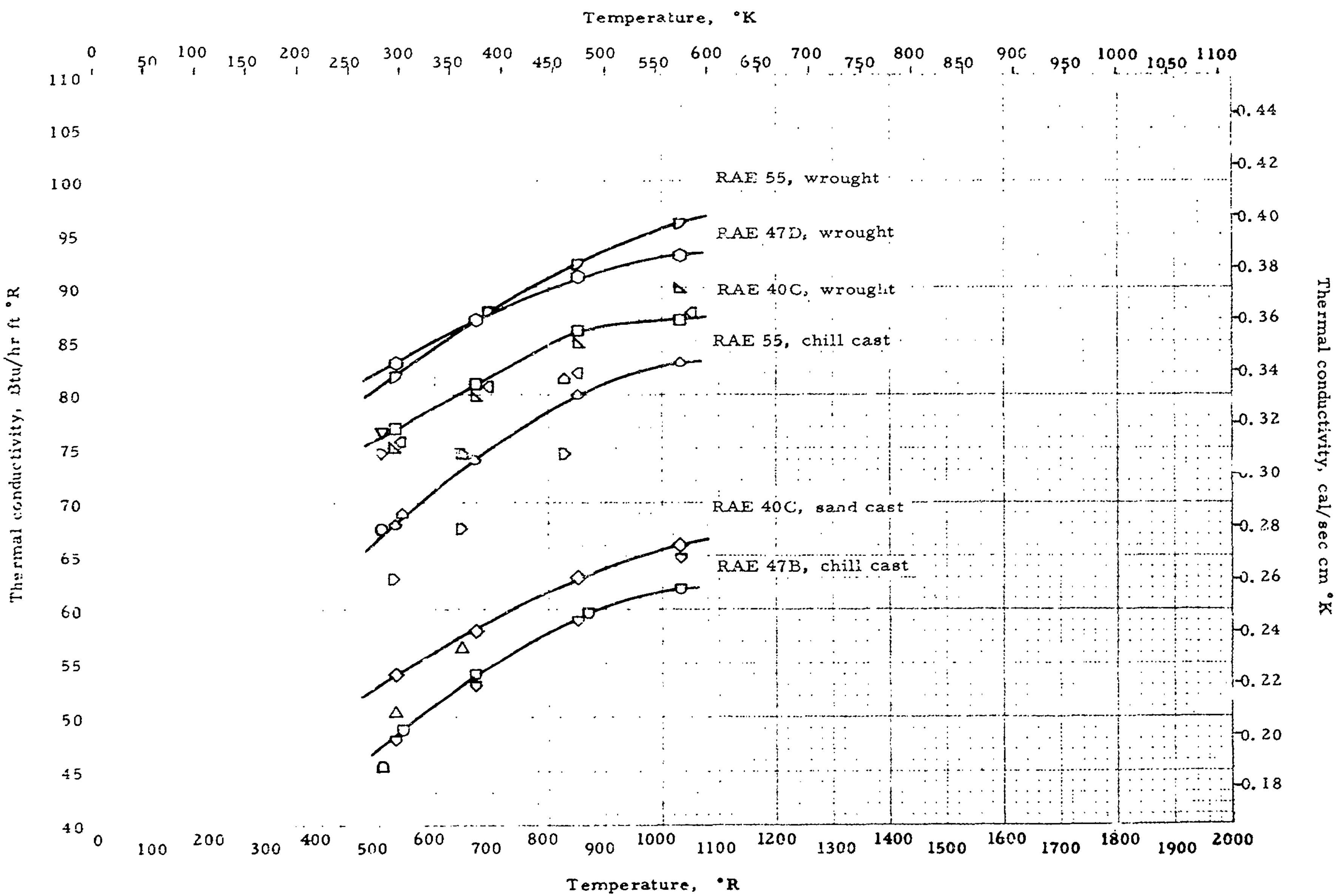


ELECTRIC RESISTIVITY -- ALUMINUM + SILVER

ELECTRIC RESISTIVITY -- ALUMINUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Koster, W. and Knödler, A.	55-122	528-1032	38% Ag	Not described here, refers to others	Furnace cooled 4 days from 550°C homogenizing temp.
□	Ibid.	55-122	540-1293	15% Ag	Same as above	Same as above
△	Powell, H. and Evans, E. J.	43-4	492-672	Not given	Not described here, refers to others	
◇	Ibid.	43-4	492-672	69.98% Al; 30.02% Ag	Same as above	
▽	Ibid.	43-4	492-672	69.79% Al; 30.21% Ag	Same as above	



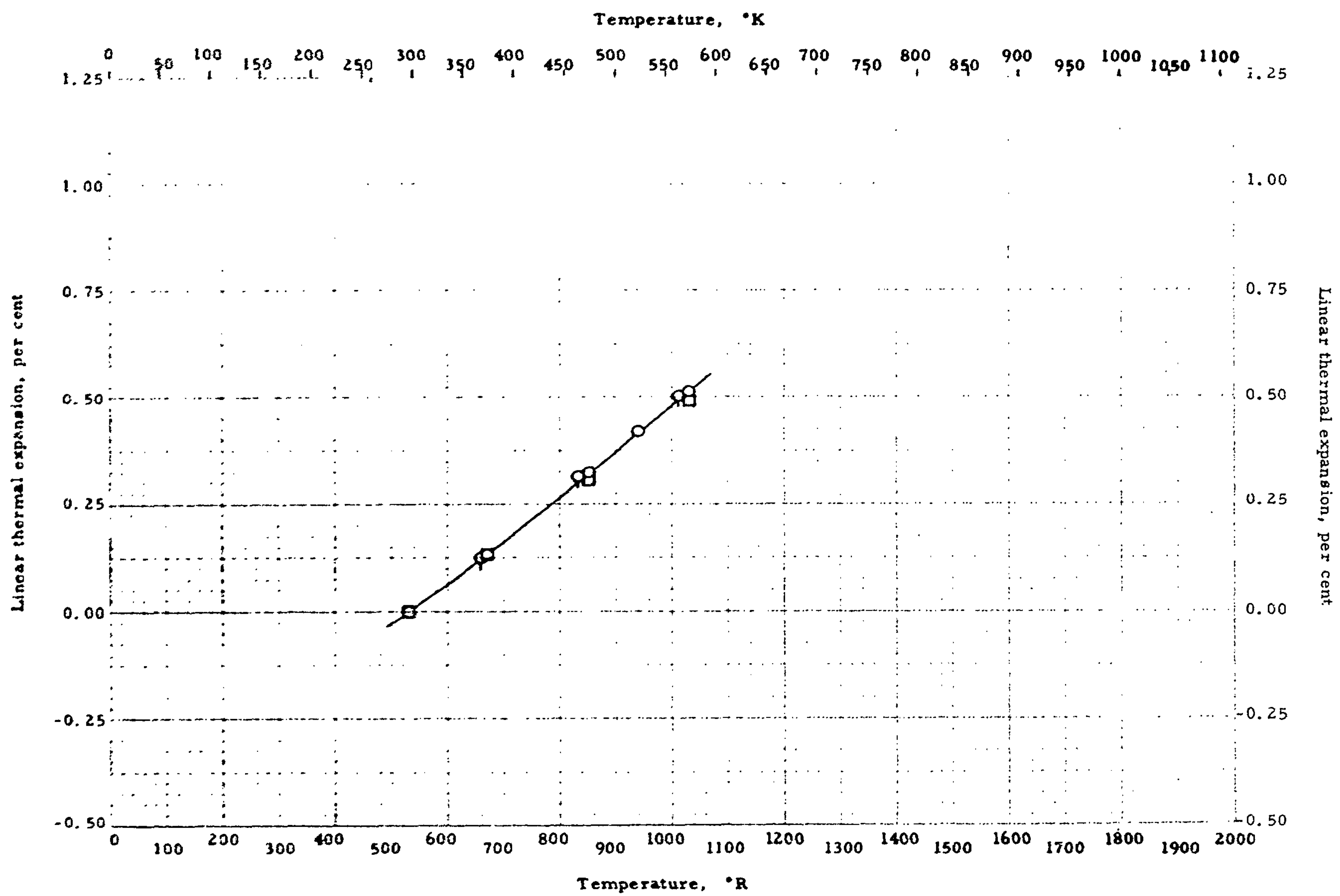
THERMAL CONDUCTIVITY -- ALUMINUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528	Al Alloy RAE 40C (British desig.): 5.0% Ni; 3.0% Mn; 1.0% Cu; 0.5% ea. Mg, Cr; <0.5% Fe; 0.4% Be; 0.3% Si	Comparative; rods with heated guard tube, temp gradient by Nichrome-const. thermocouples	Wrought, 6 hr. at 570°C, cold water quenched, aged 20 hr. at 150°C, air cooled
□	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, same as above plus heat treatment at 300°C, air cooled
△	Ibid.	49-54	528-672	Same as above	Same as above	Sand cast, 6 hr. at 570°C, cold water quenched, aged 20 hr. at 150°C, air cooled
◇	Ibid.	49-54	528-1032	Same as above	Same as above	Sand cast, same as above plus heat treatment at 300°C, air cooled
▽	Ibid.	49-54	528	Al Alloy RAE 47B (British desig.): 4.0% Ni; 3.0% Mn; 1.0% Cu; 0.5% Mg; <0.5% Fe; 0.4% Be; 0.3% Si	Same as above	Wrought, 6 hr. at 570°C, cold water quenched, aged 20 hr. at 150°C, air cooled
○	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, same as above plus heat treatment at 300°C, air cooled
□	Ibid.	49-54	528	Al Alloy RAE 47B (British desig.): 4.0% Ni; 3.0% Mn; 1.0% Cu; 0.5% ea. Mg, Fe; 0.2% ea. Si, Ti	Same as above	Sand cast
▽	Ibid.	49-54	528-1032	Same as above	Same as above	Sand cast, heat treated at 300°C, air cooled
▽	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, heat treated at 300°C, air cooled
△	Ibid.	49-54	528-852	Al Alloy RAE 55 (British desig.): 2.85% Ni, 2.02% Mn; 1.57% Cu; 0.52% Mg; 0.49% Cr; 0.41% Fe, 0.17% Si; 0.07% Ti	Same as above	Wrought, soln. heat treated 4 hr. at 570°C, quenched in boiling water, aged 40 hr. at 160°C, cooled in air. Values unreliable, segregation, blow holes in cast, cracks in forged
△	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, same as above, plus heat treatment at 300°C, air cooled
◇	Ibid.	49-54	528	Al Alloy RAE 55 (British desig.): 3.01% Ni; 1.68% Cu; 0.49% Mg; 0.40% Fe; 0.17% Cr; 0.15% Si	Same as above	Wrought, same as above without added heat treatment

REFERENCE INFORMATION

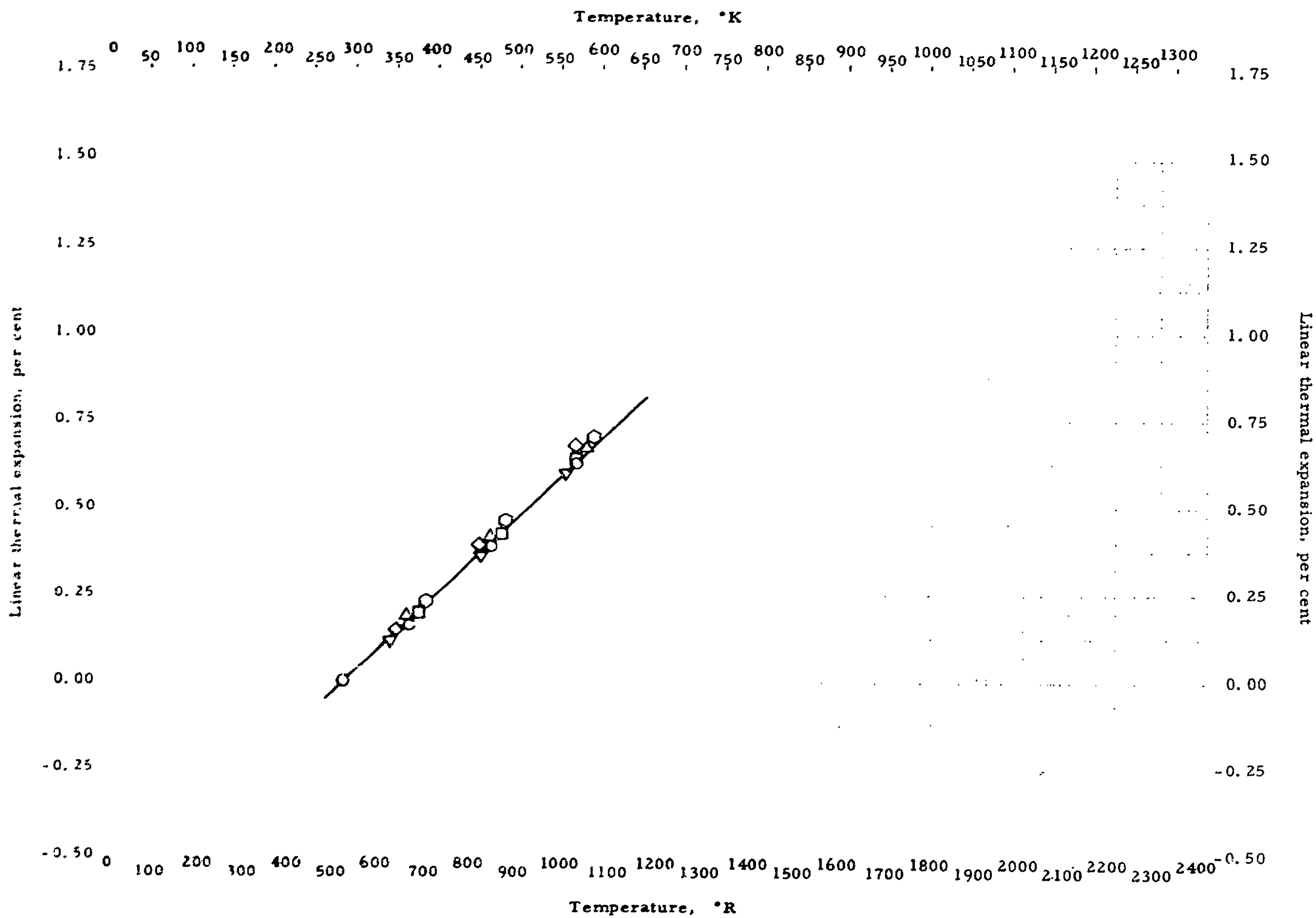
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
▽	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Al Alloy RAE 55 (British desig.): 3.01% Ni; 1.68% Cu; 0.49% Mg; 0.40% Fe; 0.17% Cr; 0.15% Si	Comparative; rods with heated guard tube, temp gradient by Nichrome-const. thermocouples	Wrought, soln. heat treated 4 hr. at 570°C, quenched in boiling water, aged 40 hr. at 160°C, cooled in air. Values unreliable, segregation, blow holes in cast, cracks in forged. Plus heat treatment at 300°C, air cooled
▷	Ibid.	49-54	528-852	Al Alloy RAE 55 (British desig.): 2.90% Ni; 1.89% Cu; 1.55% Mn; 0.56% Mg; 0.43% Fe; 0.21% Si; 0.15% Cr; 0.07% Ti	Same as above	Chill cast, soln. heat treated 4 hr. at 570°C, quenched in boiling water, aged 12 hr. at 200°C, air cooled. Values unreliable, segregation, blow holes in cast, cracks in forged
○	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, same as above, plus heat treatment at 300°C, air cooled
◁	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, same as above except final heat treatment at 400°C



LINEAR THERMAL EXPANSION -- ALUMINUM + BERYLLIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○ ♀	Hidnert, P. and Krider, H. S.	52-70	528-1032	66.5% Al; 35% Be; 0.5 - 1.0% ea. Si, Mg	Telemicroscopes sighting on wires suspended from sample	Forged, solution heat treated at about 600°F, quenched, aged at about 300 °F. ○ - heating; ♀ - cooling
□	Ibid.	52-70	528-1032	60% Al; 40% Be; trace of Ag	Same as above	Cast at 2300°F, heat treated for 24 hr. at 1025°F, hot forged, annealed 4 hr. at 1025°F; water quenched, cold worked from 3/4 in. to 5/8 in. dia.

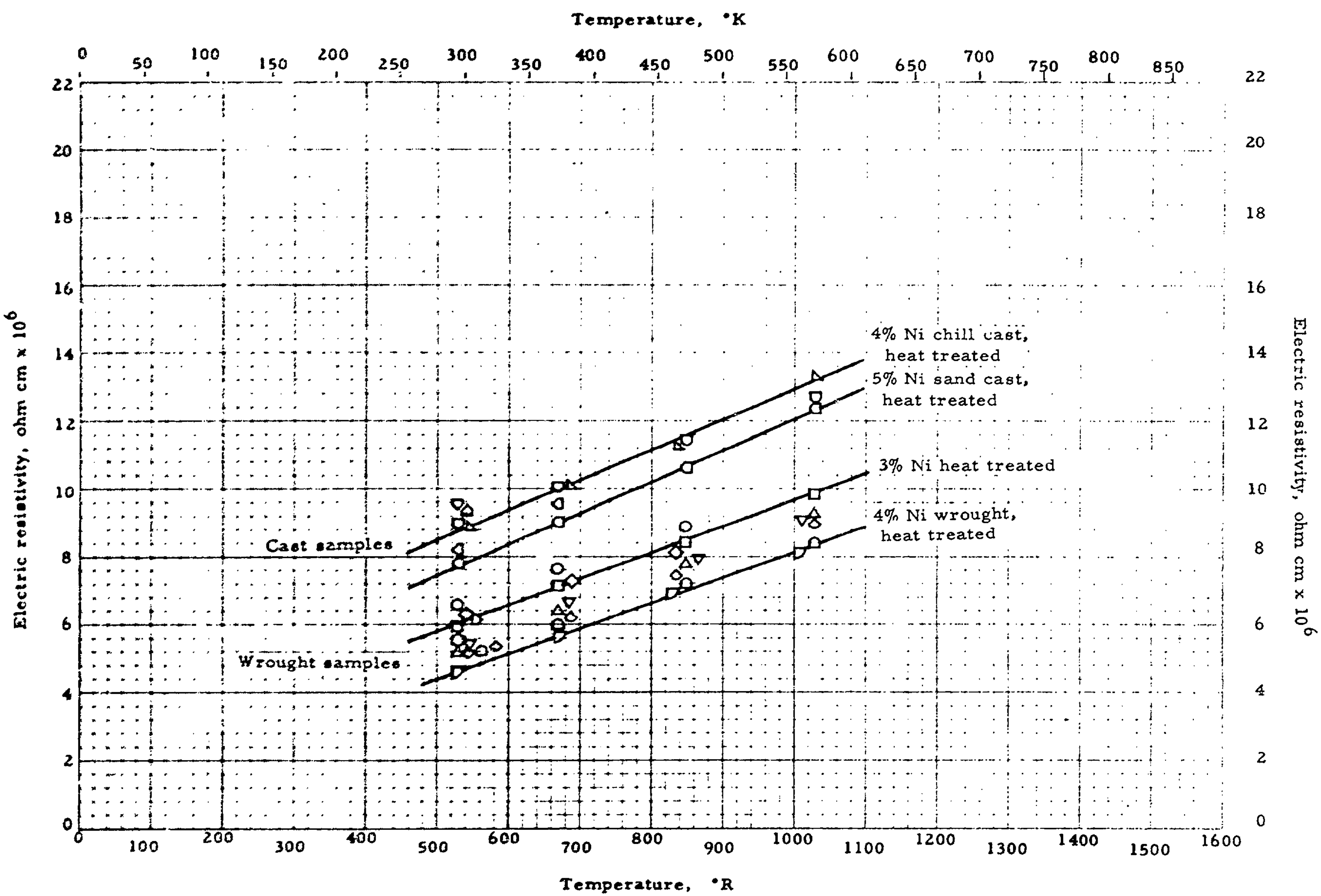


LINEAR THERMAL EXPANSION -- ALUMINUM + NICKEL + X

LINEAR THERMAL EXPANSION -- ALUMINUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Aluminum Alloy RAE 40C (British desig.): 5.0% Ni; 3.0% Mn; 2.0% Cu; 0.5% ea. Mg, Cr; <0.5% Fe, 0.4% Be; 0.3% Si	Quartz dilatometer, dial gauges; constant temp. bath	Plotted data show avg. for 2 samples (within 1.2%). Sample a) wrought Sample b) wrought, heat-treated 6 hr. at 570°C, cold water quenched, 20 hr. at 150°C, air cooled
□	Ibid.	49-54	528-1032	Same as above	Same as above	Plotted data show avg. for 2 samples (within 0.6%). Sample a) cast Sample b) cast, heat-treated as above
△	Ibid.	49-54	528-1032	Aluminum Alloy RAE 55 (British desig.): 3.05% Ni; 1.98% Mn; 1.68% Cu; 0.50% Mg; 0.45% Cr; 0.39% Fe; 0.19% Si; 0.08% Ti	Same as above	Wrought, values unreliable because of cracks
◇	Ibid.	49-54	528-1032	Aluminum Alloy RAE 55 (British desig.): 2.90% Ni; 1.89% Cu; 1.55% Mn; 0.56% Mg; 0.43% Fe; 0.21% Si; 0.15% Cr; 0.07% Ti	Same as above	Cast. Values unreliable because of segregation and blow holes
▽	Ibid.	49-54	528-1032	Aluminum Alloy RAE 470 (British desig.) 4.0% Ni; 3.0% Mn, 1.0% Cu; 0.5% Mg; <0.5% Fe; 0.4% Be, 0.3% Si	Same as above	Plotted data show avg. for 2 samples (within 1%). Sample a) wrought. Sample b) wrought, heat-treated 6 hr. at 570°C, cold water quenched, 20 hr. at 160°C, air cooled
○	Ibid.	49-54	528-1032	Aluminum Alloy RAE 47B (British desig.): 4.0% Ni; 3.0% Mn, 1.0% Cu; 0.5% ea. Mg, Fe; 0.2% ea. Si, Ti	Same as above	Cast. tested in sand cast and chill cast condition



ELECTRIC RESISTIVITY -- ALUMINUM + NICKEL + X

ELECTRIC RESISTIVITY -- ALUMINUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-852	Al Alloy RAE55 (British desig.): 2.90% Ni; 1.89% Cu; 1.55% Mn; 0.56% Mg; 0.43% Fe; 0.21% Si; 0.15% Cr; 0.07% Ti	Potential drop	As received
□	Ibid.	49-54	528-1032	Same as above	Same as above	4 hr. solution heat treated at 570°C, boiling water quenched, held 12 hr. at 200°C, air cooled. Heat treated at 300°C. Values unreliable, segregation, blow holes in cast, cracks in forged
△	Ibid.	49-54	528-1032	Same as above	Same as above	4 hr. solution heat treated at 570°C, boiling water quenched, held 12 hr. at 200°C, air cooled. Heat treated at 400°C. Values unreliable, segregation, blow holes in cast, cracks in forged
◇	Ibid.	49-54	528-852	Al Alloy RAE55 (British desig.): 2.85% Ni; 2.02% Mn; 1.67% Cu; 0.52% Mg; 0.49% Cr; 0.41% Fe; 0.17% Si; 0.07% Ti	Same as above	Wrought, as received. Values unreliable, segregation, blow holes in cast, cracks in forged
▽	Ibid	49-54	528-1032	Same as above	Same as above	Wrought, solution heat treated 40 hr. at 570°C; boiling water quenched, aged 40 hr. at 160°C, cooled in air. Values unreliable, segregation, blow holes in cast, cracks in forged
○	Ibid.	49-54	528	Al Alloy RAE55 (British desig.): 3.01% Ni; 1.68% Cu; 0.49% Mg; 0.40% Fe; 0.17% Cr; 0.15% Si	Same as above	Wrought, as received. Values unreliable, segregation, blow holes in cast, cracks in forged
□	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, solution heat treated 40 hr. at 570°C; boiling water quenched, aged 40 hr. at 160°C, cooled in air. Values unreliable, segregation, blow holes in cast, cracks in forged
▽	Ibid.	49-54	528	Al Alloy RAE 47B (British desig.): 4.0% Ni; 3.07% Mn; 1.0% Cu; 0.5% ea. Mg, Fe; 0.2% ea. Si, Ti	Same as above	Sand cast, as received

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, R. W., Hickman, M. J. and Barber, C. R.	49-54	528-1032	Al Alloy RAE 47B (British desig.): 4.0% Ni; 3.07% Mn; 1.0% Cu; 0.5% ea. Mg, Fe; 0.2% ea. Si, Ti	Potential drop	Sand cast, heat treated
○	Ibid.	49-54	528	Same as above	Same as above	Chill cast, as received
△	Ibid.	49-54	528-1032	Same as above	Same as above	Chill cast, heat treated
○	Ibid.	49-54	528	Al Alloy RAE47D (British desig.): 4.0% Ni; 3.0% Mn; 1.0% Cu; 0.5% Mg; <0.5% Fe; 0.4% Be, 0.3% Si	Same as above	Wrought, as received
▽	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heat treated 6 hr. at 570°C, cold water quenched, aged 20 hr. at 160°C, air cooled
▷	Ibid.	49-54	528	Al Alloy RAE40C (British desig.): 5.0% Ni; 3.07% Mn; 2.0% Cu, 0.5% ea. Mg, Cr; <0.5% Fe; 0.4% Be; 0.3% Si	Same as above	Wrought, as received
○	Ibid.	49-54	528-1032	Same as above	Same as above	Wrought, heat treated 6 hr. at 570°C, cold water quenched, aged 20 hr. at 150°C, air cooled
○	Ibid.	49-54	528-672	Same as above	Same as above	Sand cast, as received
○	Ibid.	49-54	528-1032	Same as above	Same as above	Sand cast, heat treated, 6 hr. at 570°C, cold water quenched, aged 20 hr. at 150°C, air cooled

PROPERTIES OF MAGNESIUM + ALUMINUM + ZINC + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	111 lb_m/ft^3 *	1.78 g/cm^3 *
Melting Point	1508°R *	838°K *
Heat of Fusion	146 Btu/lb_m *	81 cal/g *
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* 3% Al; 1% Zn

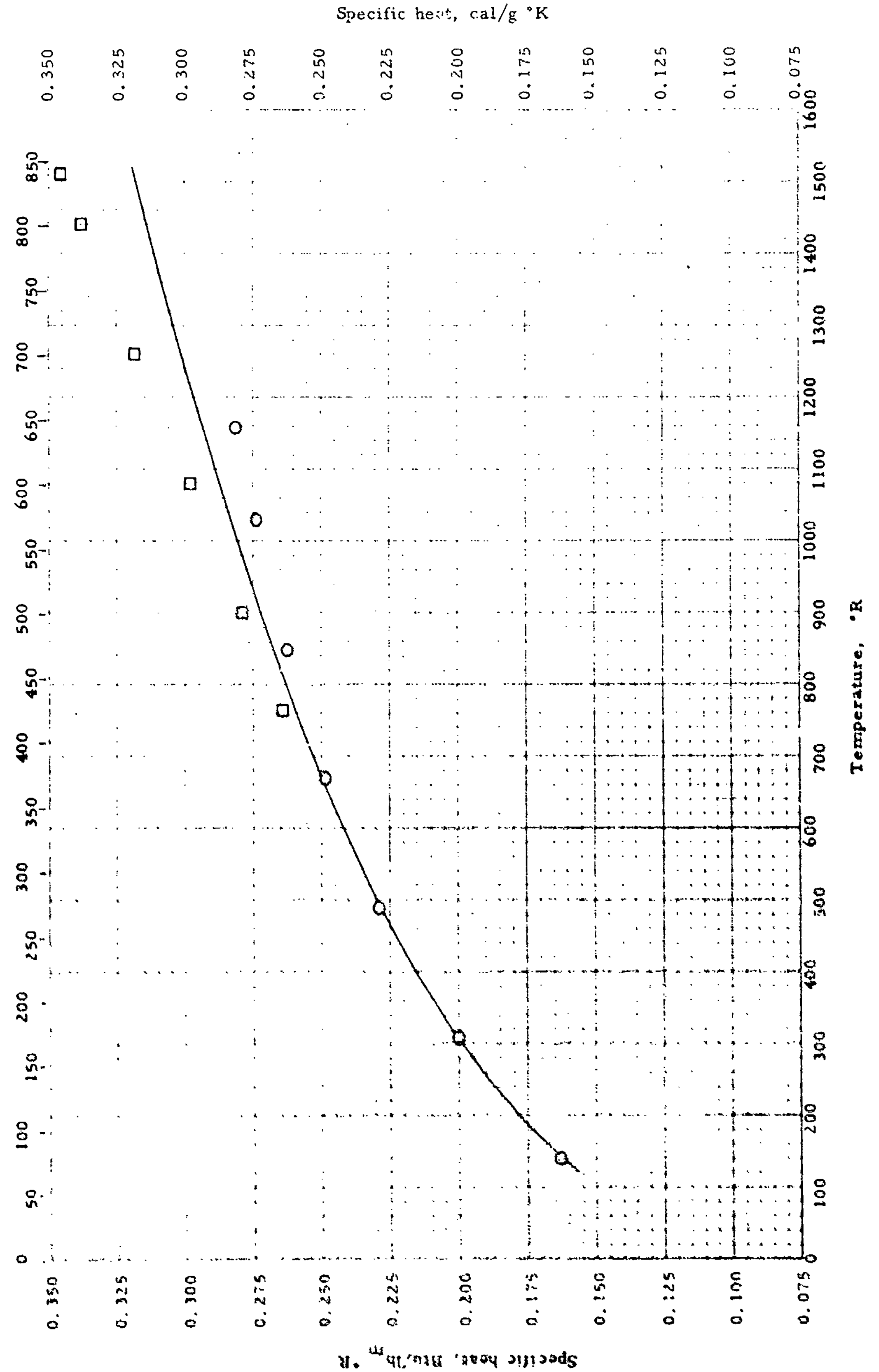
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	111	1.78
Melting Point:		°R	°K
	□	1508	838
Heat of Fusion:		Btu/lb_m	cal/g
	□	146 ± 4	81 ± 2
[illegible]		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF MAGNESIUM + ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C. F. and Deem, H. W.	58-5 51-65	528	AN-M-29: nominal: 95.7% Mg; 3.0% Al; 1.0% Zn; 0.3% Mn	ρ: weight and volume by water displacement	Hot rolled, annealed 1 hr. at 600°F and furnace cooled
□	Baker, H.	57-54	1598 1508	AZ 31A and B: nominal: 95.5% Mg; 3.0% Al; 1.0% Zn; 0.5% Mn	MP: not given Δh_f: not given	

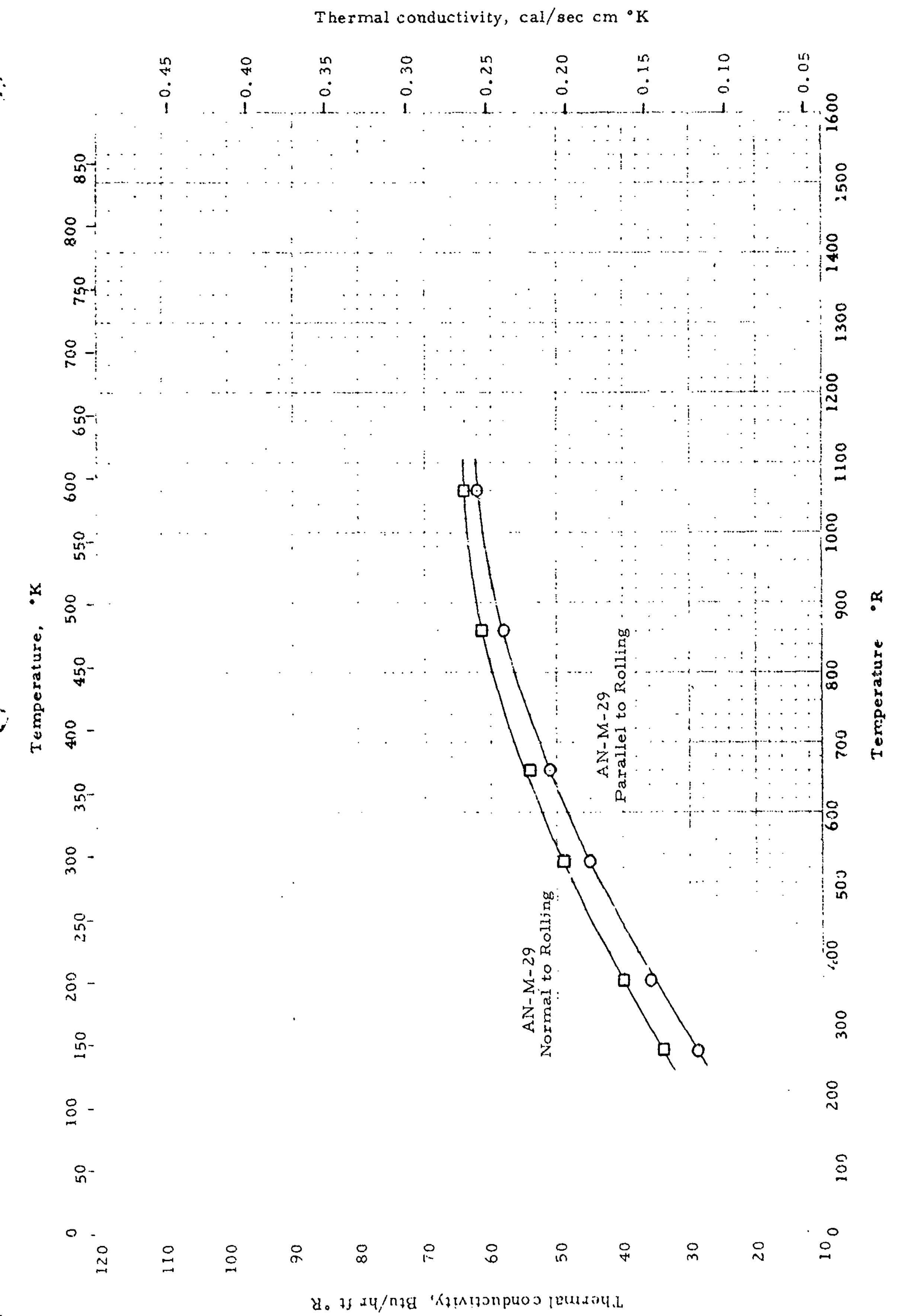


SPECIFIC HEAT -- MAGNESIUM + ALUMINUM + ZINC + X

SPECIFIC HEAT -- MAGNESIUM + ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F., Matolich, J., and Van Velzor, J.A.	54-27 also 58-5		Mg alloy AN-M-29: 95.7% Mg; 3.0% Al; 1.0% Zn, 0.3% Mn	Drop method; ice calorimeter	
□	Baker, H.	47-19	768-1568	Mg alloy AZ 31 B; 95.5% Mg; 3.0% Al, 1.0% Zn, 0.5% Mn	Drop method	Machined from permanent-mold cast material

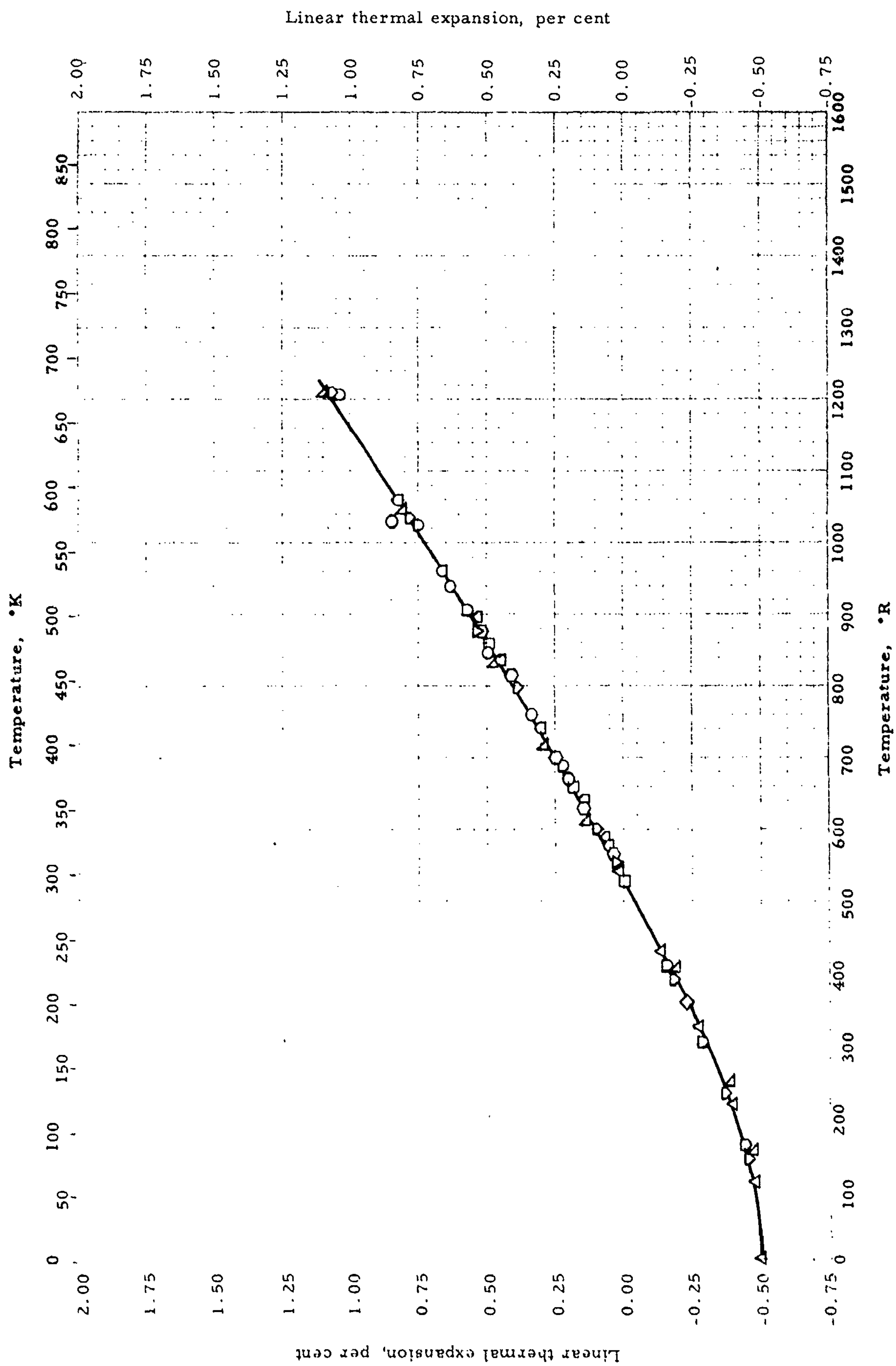


THERMAL CONDUCTIVITY -- MAGNESIUM + ALUMINUM + ZINC + X

THERMAL CONDUCTIVITY -- MAGNESIUM + ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lucks, C.F. and Deem, H. W.	58-5 also 51-65	260-1060	AN-M-29 (Dow Chem. Co.) 95.7% Mg; 3% Al; 1% Zn; 0.3% Mn $\rho = 111\ lb_m/ft^3$	Comparative, rods (Armco Iron standard)	Annealed 1 hr. at 1600°F, furnace cooled. Measurements made parallel to rolling direction
□	Ibid.	58-5 also 51-65	260-1060	Same as above	Same as above	Treated as above. Measurements made normal to rolling direction.



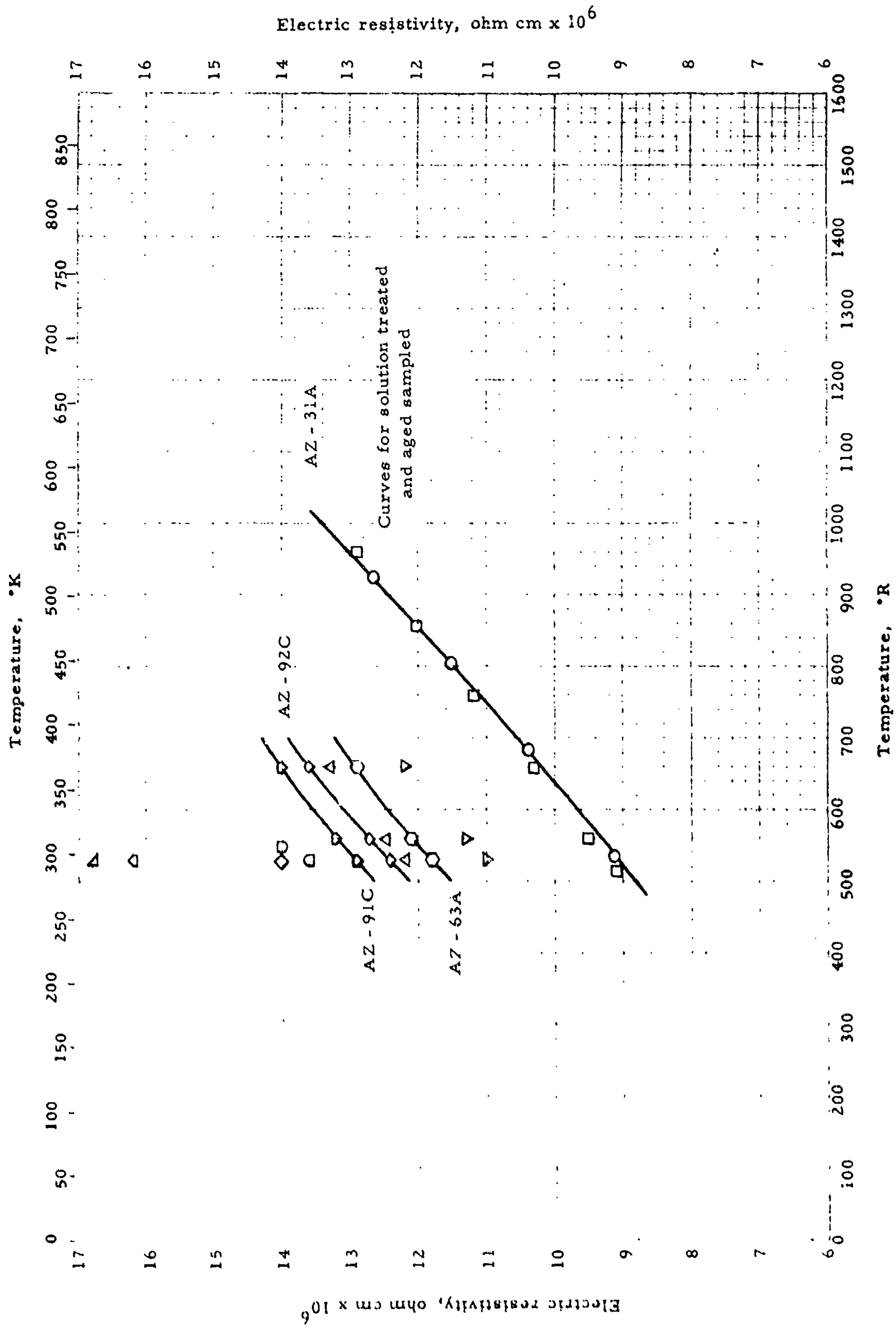
LINEAR THERMAL EXPANSION -- MAGNESIUM + ALUMINUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dow Chemical Co.	54-41	672-1032	6.02% Al; 3.10% Zn; 0.26% Mn; 0.017% Fe; <0.01% ea. Ca, Si, Sn; 0.002% Cu; <0.001% ea. Ni, Pb	Bollenrath type comparative dilatometer (Chronin standard)	Sample tested in the "as fabricated" condition. This composition fits a nominal Mg Alloy AZ63A
□	Dow Chemical Co.	54-11	528-860	Mg Alloy AZ81 (Cast); nominal: 7.0-8.1% Al; 0.4-1.0% Zn; 0.3% max. Si; 0.13% min. Mn; 0.10% max. ea. Cu, Ni; 0.3% max. others	Bollenrath type comparative dilatometer (Chronin standard)	Solution heat treated. Expansion coefficient for Chronin given as $13.9 \times 10^{-6}/°C$ giving $(15.04 \pm 0.15) \times 10^{-6}/°F$ for AZ81
△	Laquer, H. L.	52-39	0-540	Mg Alloy FS-1: 96% Mg; 3.0% Al; 1.0% Zn	Quartz tube dilatometer with dial gauges	
◇	Perry, S.	45-6	360-528	2 samples: a) Dow metal J (AZ61X): 92.8% Mg; 6% Al; 1% Zn, 0.2% Mn. b) Dow metal C (AZ92): 88.9% Mg; 9% Al; 2% Zn, 0.1% Mn	Quartz tube dilatometer with dial gauges	Two samples, plotted identically. Auth. est. accuracy ± 3.4%
▽	Wood, J. E. et al.	55-40	537-879	Mg Alloy AX81XA: 8.00% Al; 0.76% Zn; 0.21% Mn; 0.01% Si, <0.01% ea. Ca, Sn; 0.003% Pb; 0.001% Fe, <0.001% ea. Cu, Ni	Comparative dilatometer (Chronin standard)	Cast. Solution heat treated
○	Ibid	55-40	540-880	2 samples AZ31A 3.12% Al; 1.07% Zn; 0.49% Mn; 0.16% Ca; <0.01% ea. Si, Sn; 0.0044% Fe; 0.001% Cu; <0.001% Pb; <0.0005% Ni and AZ31B 3.14% Al; 1.05% Zn; 0.49% Mn; <0.01% ea. Ca, Si, Sn; 0.0047% Fe; <0.001% ea. Cu, Pb; <0.0005% Ni	Same as above	Plotted avg. of 4 samples, 2 conditions for each alloy, all within ± 0.4%: a) as cast b) cast and solution heat treated
◻	Ibid.	55-40	540-1060	Mg Alloy AZ63A: 6.02% Al; 3.10% Zn; 0.26% Mn; 0.017% Fe; <0.01% ea. Si, Sn, Ca; 0.002% Cu; <0.001% ea. Ni, Pb	Same as above	Plotted avg. of 4 samples within ± 2%: a) as fabricated b) aged c) solution heat treated d) solution heat treated and artificially aged
◻	Lucks, C. F., Thompson, H. B. et al	51-65 also 58-5	150-1220	Mg Alloy A-N-M-29: 2.5-3.5% Al; 0.7 - 1.3% Zn; < 0.3% Si; <0.2% Mn; < 0.05% Cu; <0.005% ea. Ni, Fe; <0.03% others	Quartz tube dilatometer, tested at 1.5-2.5°C/min. rise in Argon atmosphere	Hot rolled, annealed 1 hr. at 600°F and furnace cooled. Meas. perpendicular to rolling direction

REFERENCE INFORMATION

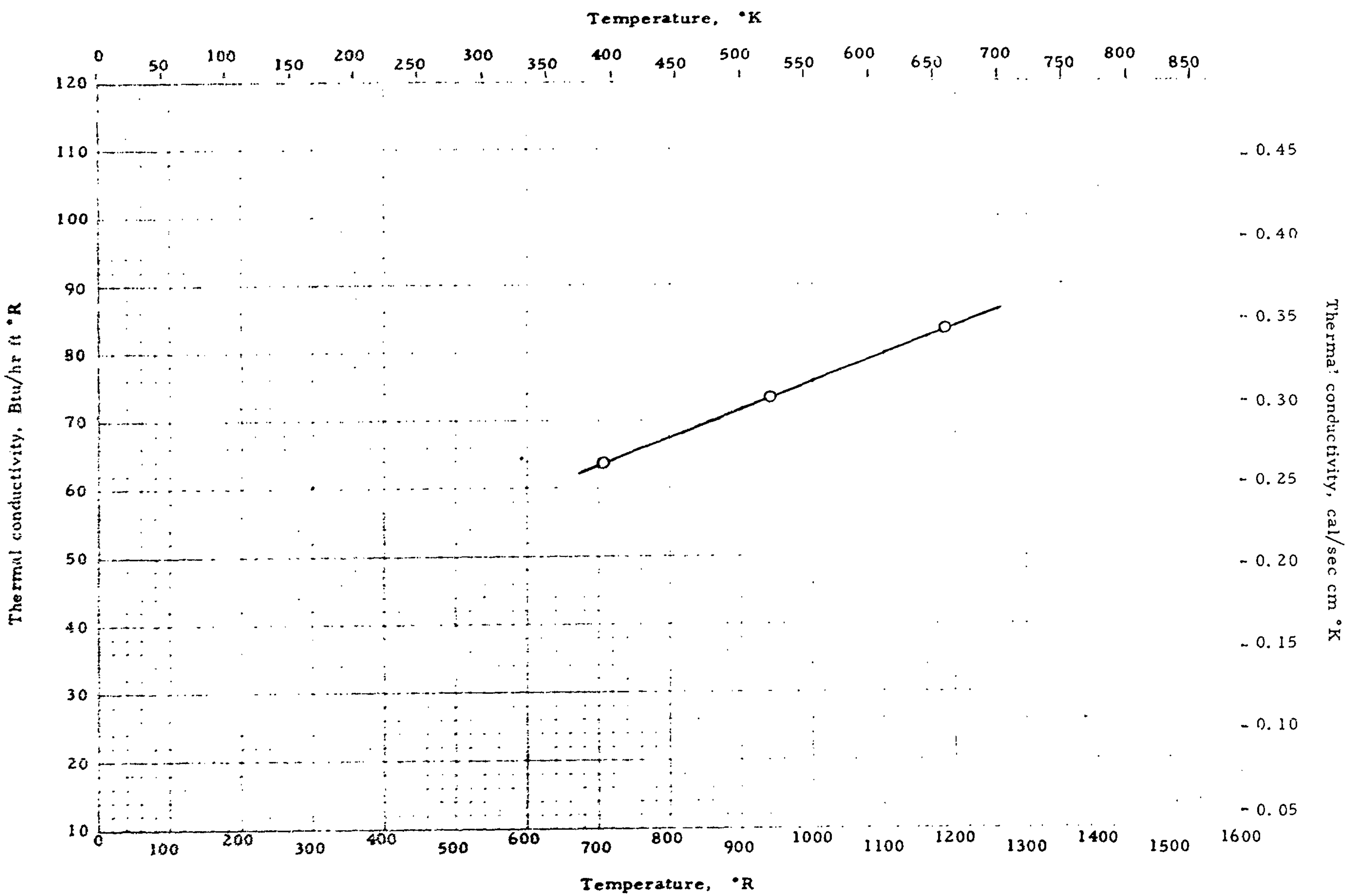
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
▽	Ibid.	51-55 58-5	150-1220	Same as above	Same as above	Same heat treatment as above. Meas. parallel to rolling direction
◺	Ibid.	51-55 58-5	150-1220	Same as above	Same as above	Same heat treatment as above. Meas. across thickness of sheet
△	Wood, J.E. et al.	55-40	530-880	Mg Alloy AZ92A. nominal: 8.3 - 9.7% Al; 1.6 - 2.4% Zn; >0.10% Mn; <0.3% Si; <0.1% Cu; <0.01% Ni; <0.3% others	Comparative dilatometer with Chronin standard	Plotted avg. of 2 samples within $\pm$ 0.1%: a) cast and aged b) cast, solution heat treated and artificially aged



ELECTRIC RESISTIVITY -- MAGNESIUM + ALUMINUM + ZINC + X

REFERENCE INFORMATION

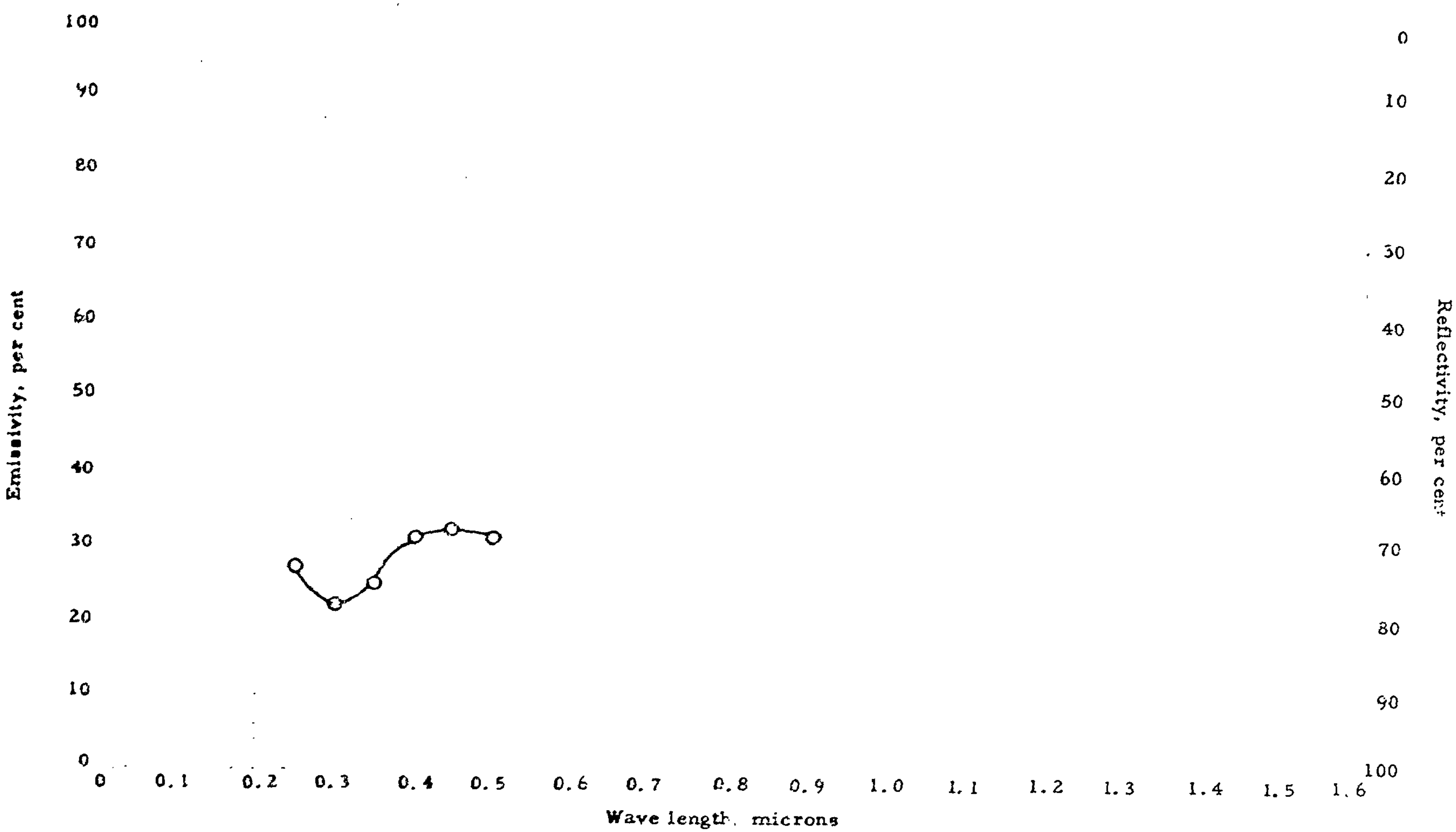
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G.S., Couling, S.L. et al.	56-22	535-926	AZ 31A; cast; 3.12% Al; 1.07% Zn; 0.49% Mn; 0.16% Ca; <0.01% ea. Si, Sn; 0.0044% Fe; 0.001% Cu; <0.001% Pb; <0.0005% Ni	Kelvin bridge	Plotted curve is the avg. between "as fabricated" and solution heat treated specimens. Max. deviation from avg. is $\pm 0.025 \times 10^{-6}$ ohm cm
□	Baker, H.	57-54	528-660	Magnesium Alloy AZ31A and B. 95.5% Mg; 3.0% Al; 1.0% Zn; 0.5% Mn	Kelvin double bridge	Samples cast and wrought. In two conditions as fabricated and solution heat treated
△	Ibid.	57-54	528-660	Magnesium Alloy AZ63A. 90.8% Mg; 6.0% Al; 3.0% Zn; 0.2% Mn	Same as above	As fabricated
◇	Ibid.	57-54	528-660	Same as above	Same as above	Solution heat treated
▽	Ibid.	57-54	528-660	Same as above	Same as above	Aged
○	Ibid.	57-54	528-660	Same as above	Same as above	Solution heat treated and aged
□	Ibid.	57-54	528-660	Magnesium Alloy AZ91C. 90.4% Mg; 8.7% Al; 0.7% Zn, 0.2% Mn	Same as above	As fabricated
△	Ibid.	57-54	528-660	Same as above	Same as above	Solution heat treated
▽	Ibid.	57-54	528-660	Same as above	Same as above	Solution heat treated and aged
□	Ibid.	57-54	528-660	Magnesium Alloy AZ92A. 88.8% Mg; 9.0% Al; 2.0% Zn; 0.2% Mn	Same as above	As fabricated
△	Ibid.	57-54	528-660	Same as above	Same as above	Solution heat treated
◇	Ibid.	57-54	528-660	Same as above	Same as above	Same data for 2 samples: Sample a) aged and Sample b) solution heat treated and aged



THERMAL CONDUCTIVITY -- MAGNESIUM + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hase, R., Heierberg, R. and Walkenhorst, W.	40-16	708-1185	Hydronalium 71 (German desig.). Nominal: 92% Mg; 7% Al; 1% Si	Temp. distribution along resistance heated rod, in vacuum. Temp. by thermocouple	Radiation less than 5%. Cast at 700 C into molds at 200°C, rolled and drawn, then turned into rods

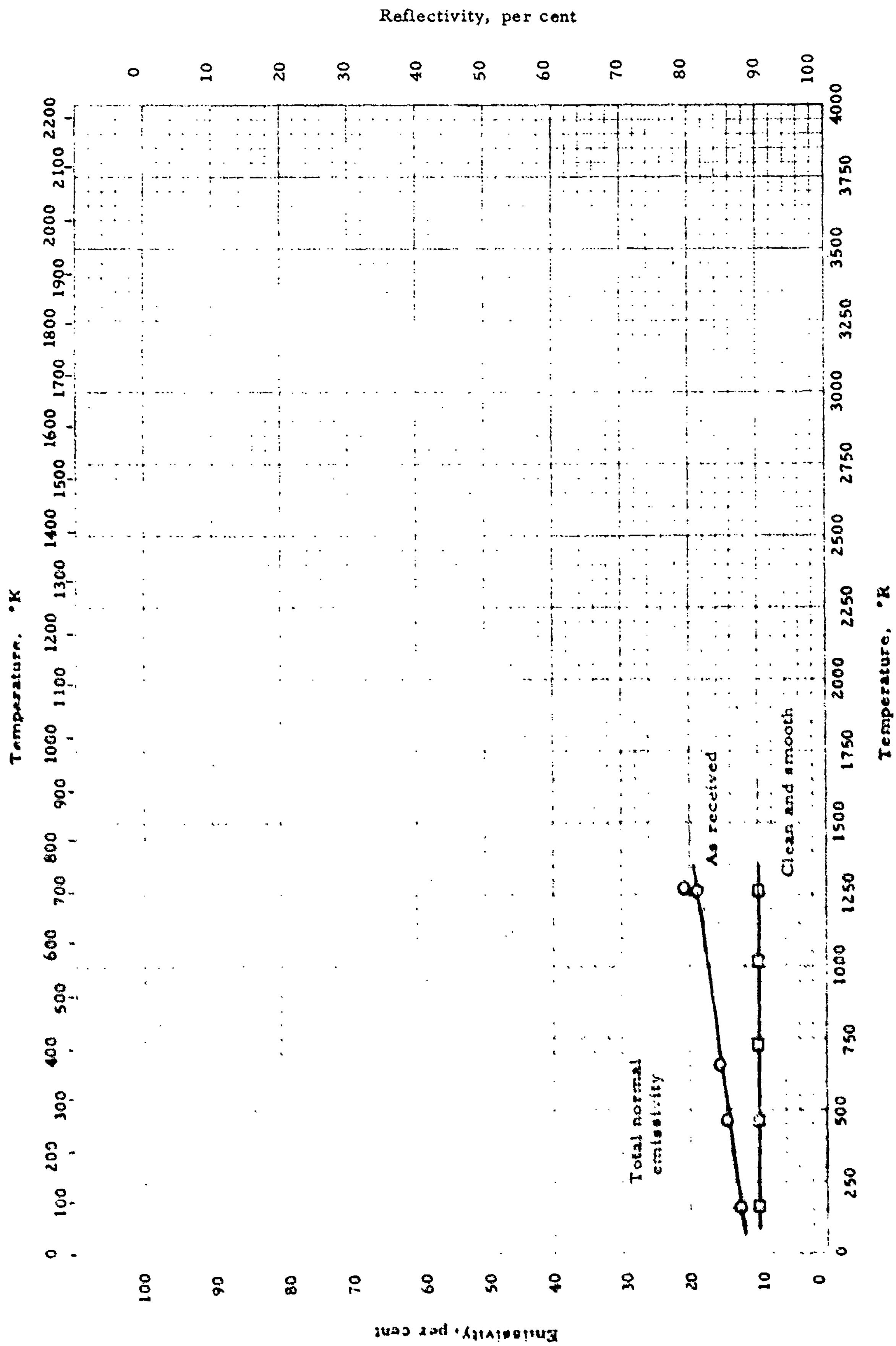


SPECTRAL EMISSIVITY -- MAGNESIUM + ALUMINUM

SPECTRAL EMISSIVITY -- MAGNESIUM + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Boettcher, A.	50-28	Room	42.0 % Al; δ phase	Spectral reflectivity at 45°; intensity of direct U. V. light and that reflected at 45° compared on photographic plate	Evaporated metal layer, heat treated after deposit to ensure complete alloying

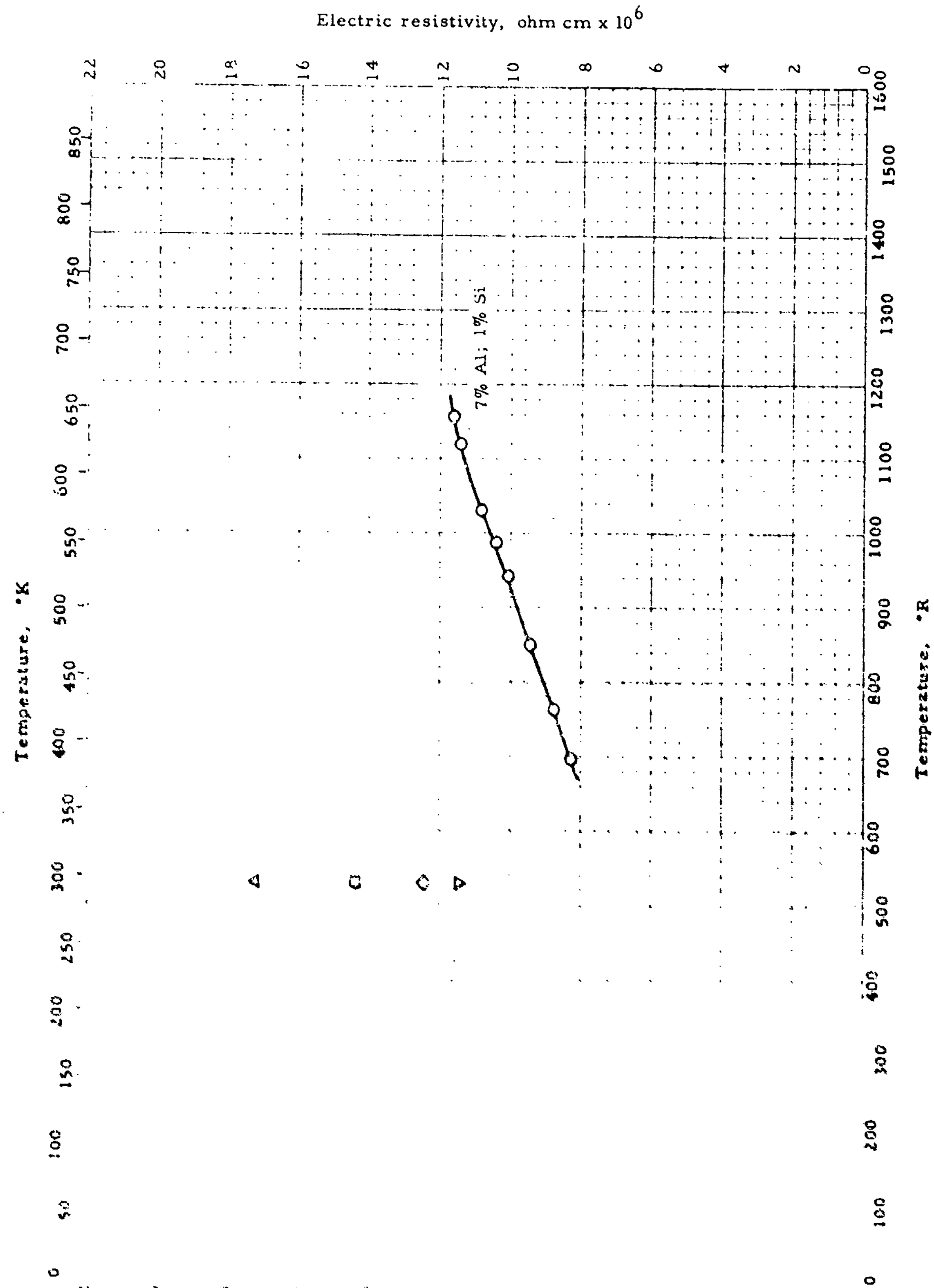


EMISSIVITY -- MAGNESIUM + ALUMINUM + X

EMISSIVITY -- MAGNESIUM + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilkes, G. B.	54-122	160-1270	Dow metal	Total normal emissivity: comparative: radiant heat flow compared with that of a black body. Tested in He atm. of 10μ Hg. Temp. by Chromel-Alumel thermocouple	As received: wiped with toluene until clean, then with alcohol. Auth. also gives values for cooling and reheating
□	Ibid.	54-122	160-1260	Same as above	Same as above	Clean and smooth: scrubbed with ivory soap, washed with water, dried, wiped with toluene and alcohol. Auth. also gives values for cooling and reheating

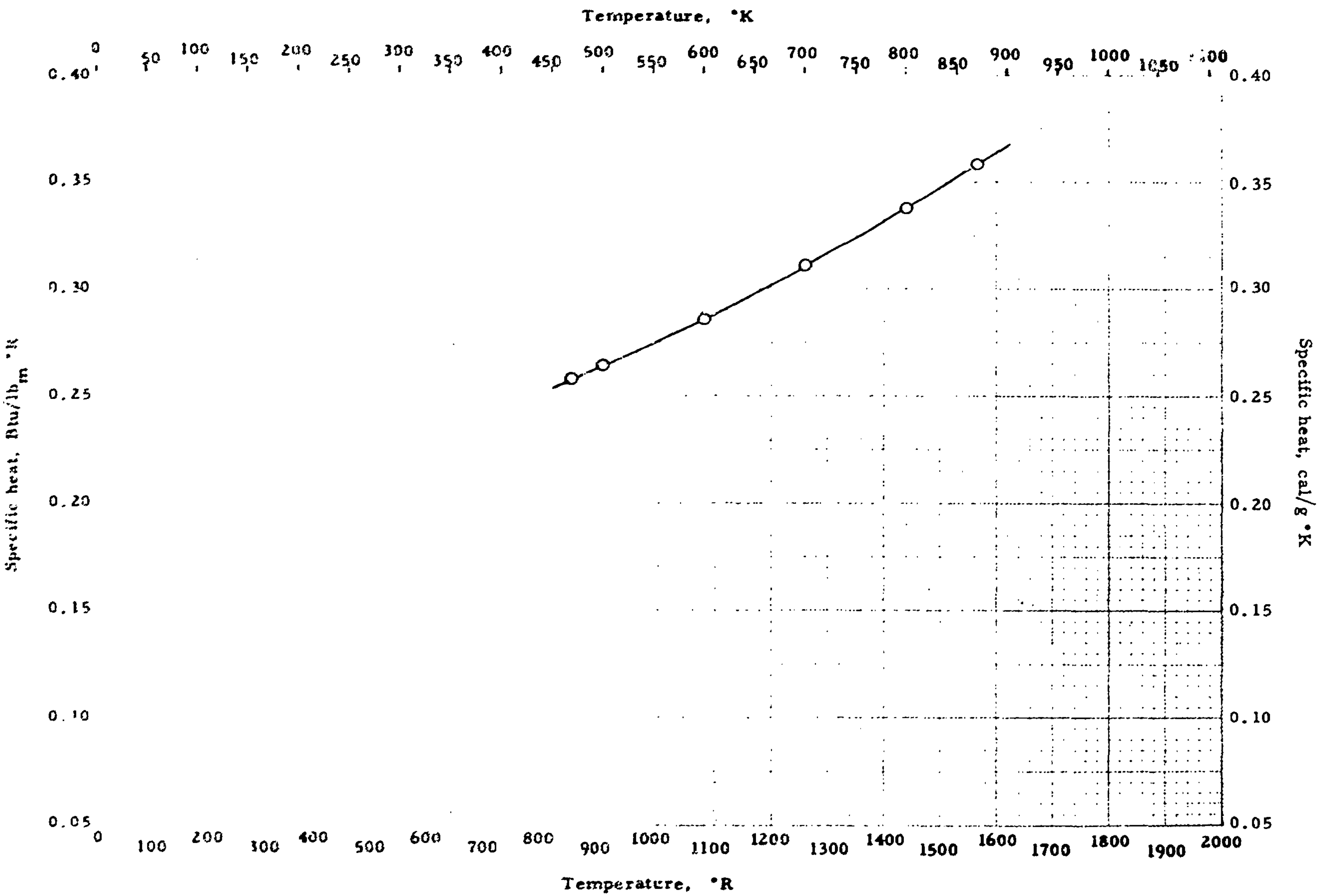


ELECTRIC RESISTIVITY -- MAGNESIUM + ALUMINUM + X

ELECTRIC RESISTIVITY -- MAGNESIUM + ALUMINUM + X

REFERENCE INFORMATION

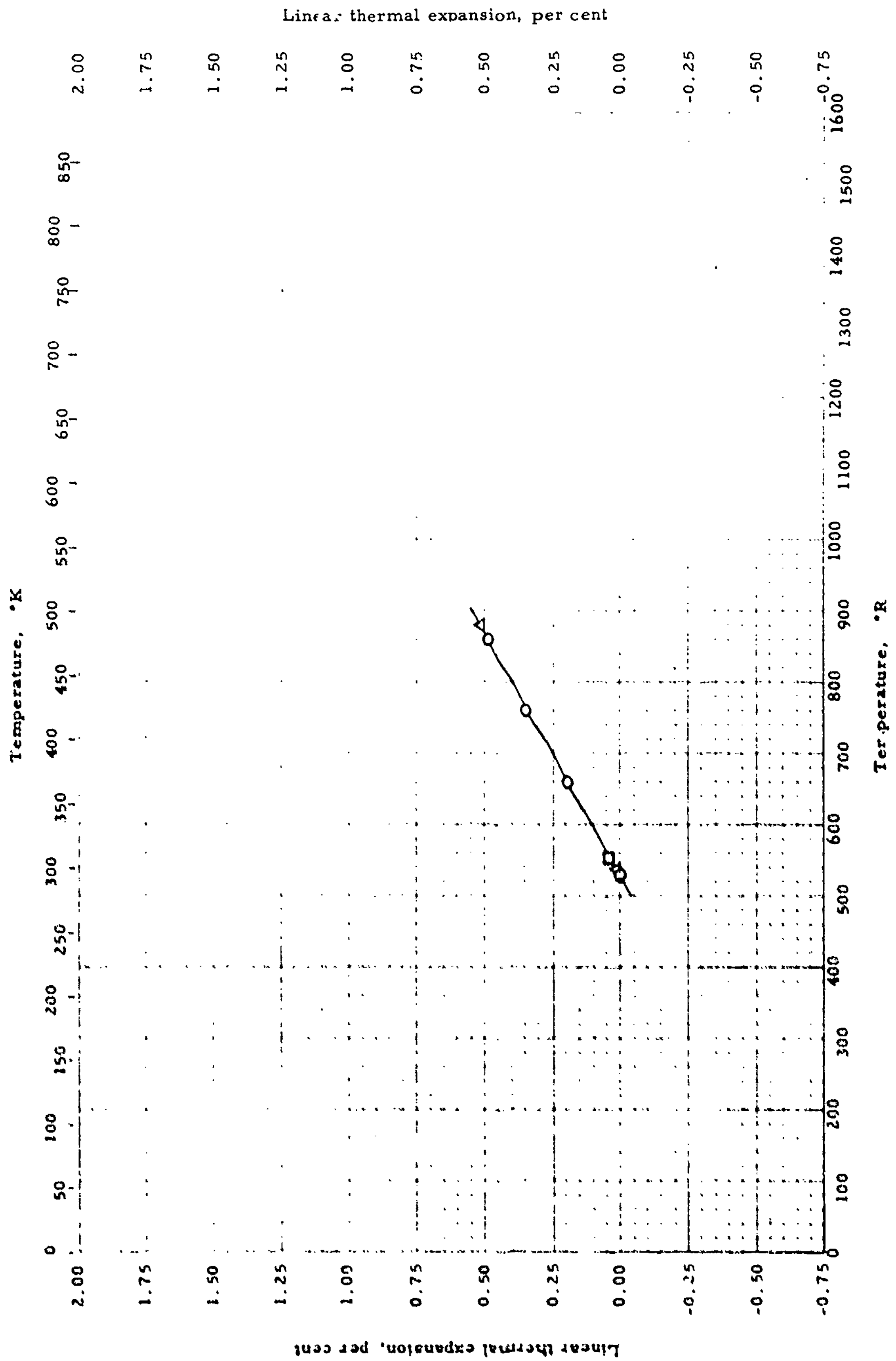
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hase, R., Heterberg, R. and Walkenhorst, W.	40-16	698-1158	Hydronalium-71 (German Desig.) Nominal: 7% Al; 1% Si	Potential drop, thermocouple	Cast at 700 °C into molds at 200 °C, rolled and drawn, then turned into rods
□	Baker, H.	57-54	528	Magnesium Alloy Am 100A; 89.8% Mg; 10.0% Al; 0.2% Mn	Kelvin double bridge	Cast
△	Ibid.	57-54	528	Same as above	Same as above	Solution heat treated
◇	Ibid.	57-54	528	Same as above	Same as above	Solution heat treated and aged
▽	Ibid.	57-54	528	Same as above	Same as above	Temper T61



SPECIFIC HEAT -- MAGNESIUM + RARE EARTH + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Baker, H.	57-54	470-870	Mg Alloy HM 31 XA; 2.98% total rare earths; 1.40% Mn; 0.05% Zn; 0.03% Al	Drop method; calorimeter not described	

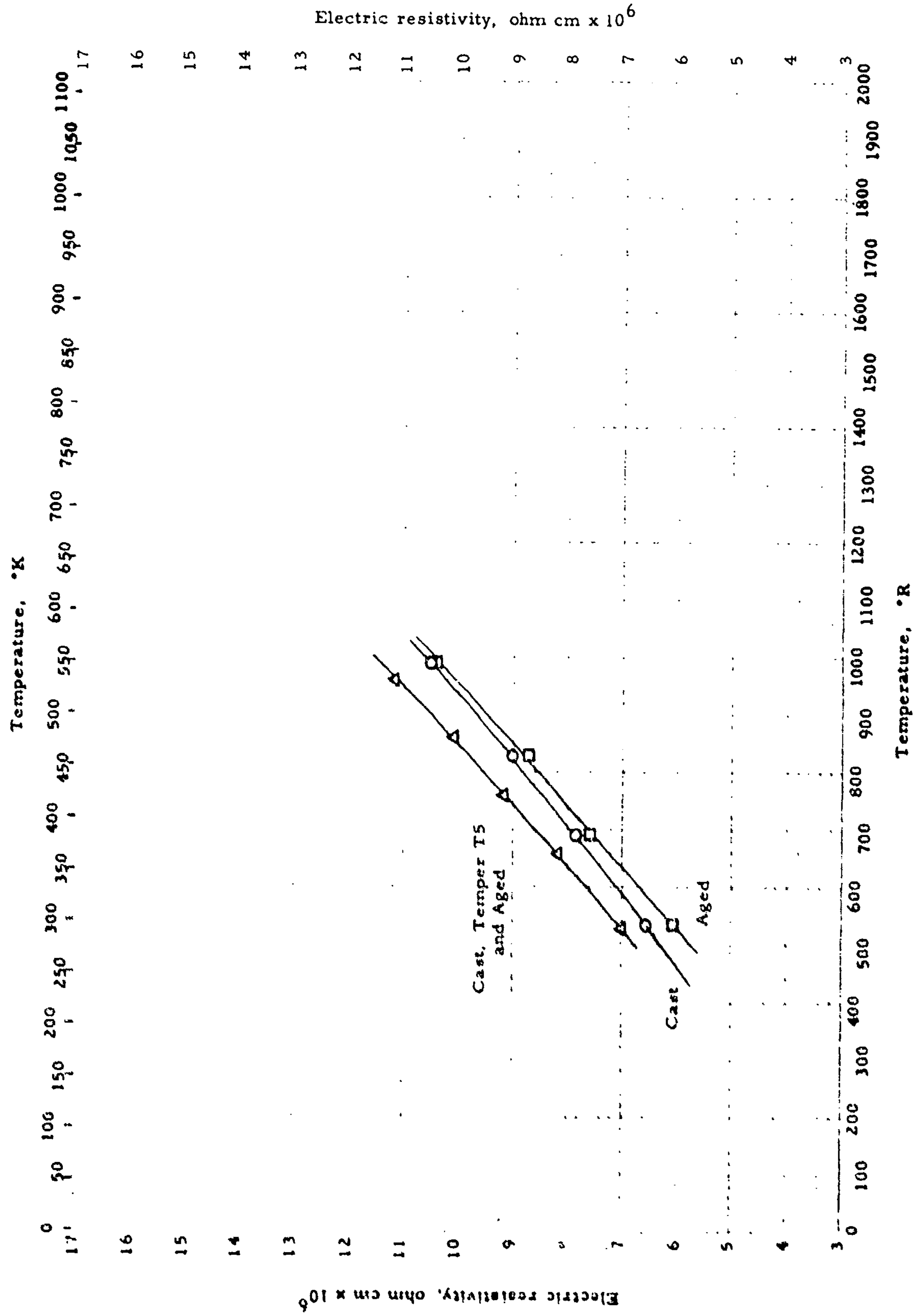


LINEAR THERMAL EXPANSION -- MAGNESIUM + RARE EARTH + X
(2-5% rare earths)

LINEAR THERMAL EXPANSION -- MAGNESIUM + RARE EARTH + X
(2-5% rare earths)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dow Chemical Co.	54-11	528-860	Mg Alloys EK30, EK32A, EK33A, EK41 (Cast). No analyses given. Nominal: 2-5% rare earths, <3.5% Zn; ≤ 1% others	Bollenrath type comparative dilatometer (Chronin standard)	All samples aged. Results for the four materials are within ± 0.8% of the average values plotted.
△	Wood, J. E., ed.	55-40	537-879	Mg Alloy EZ 33A. 3.09% rare earths; 2.39% Zn; 0.68% Zr; 0.044% ea. Mn, Cu; <0.03% Al; <0.01% ea. Ca, Si, Sn; 0.005% Pb; <0.001% ea. Fe, Ni	Bollenrath type comparative dilatometer (Chronin standard)	Cast; aged
□	Johnson, H. A.	54-100	528-555	Magnesium Alloy EK30A. Nominal: 2.5 - 4.4% rare earths; 0.2% Zr min; 0.3% Zn max; 0.3% others max	Electric strain gages on sample in const. temp. bath	Cast, T6 treatment, 16 hr. at 1050°C; 16 hr. at 400°F. Auth. est. accuracy ± 1%

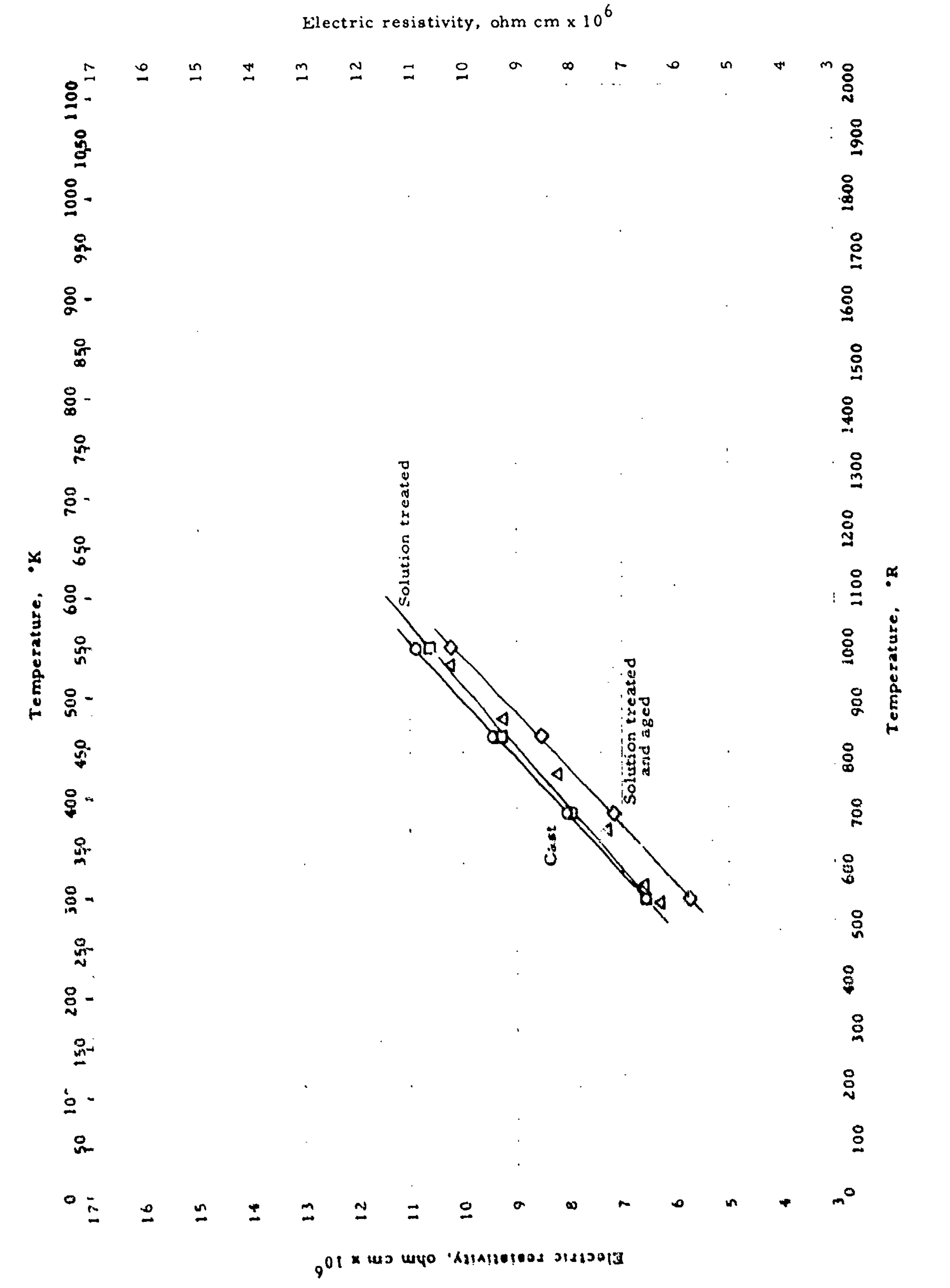


ELECTRIC RESISTIVITY -- MAGNESIUM + RARE EARTH + ZINC + X
Alloy EZ-33A

ELECTRIC RESISTIVITY -- MAGNESIUM + RARE EARTH + ZINC + X
Alloy EZ-33A

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G. S., Couling, S. L. et al.	56-22	536-989	3.09% rare earth, 2.39% Zn, 0.68% Zr, 0.044% Mn, <0.03% Al, 0.01% Ca, <0.01% Si, <0.01% Sn, 0.005% Pb, 0.004% Cu, <0.001% Fe, <0.001% Ni	Kelvin double bridge	As fabricated. Average values for two samples plotted. Max. dev. from mean 1.1%
□	Ibid	56-22	536-989	Same as above	Same as above	Aged. Avg. values for two samples plotted. Max. dev. from mean 1.25%
△	Baker, H	57-54	528-960	3.0% total rare earths, 2.6% Zn, 0.65% Zr	Kelvin double bridge. Sample in heated silicone fluid	Cast Temper-T5-aged

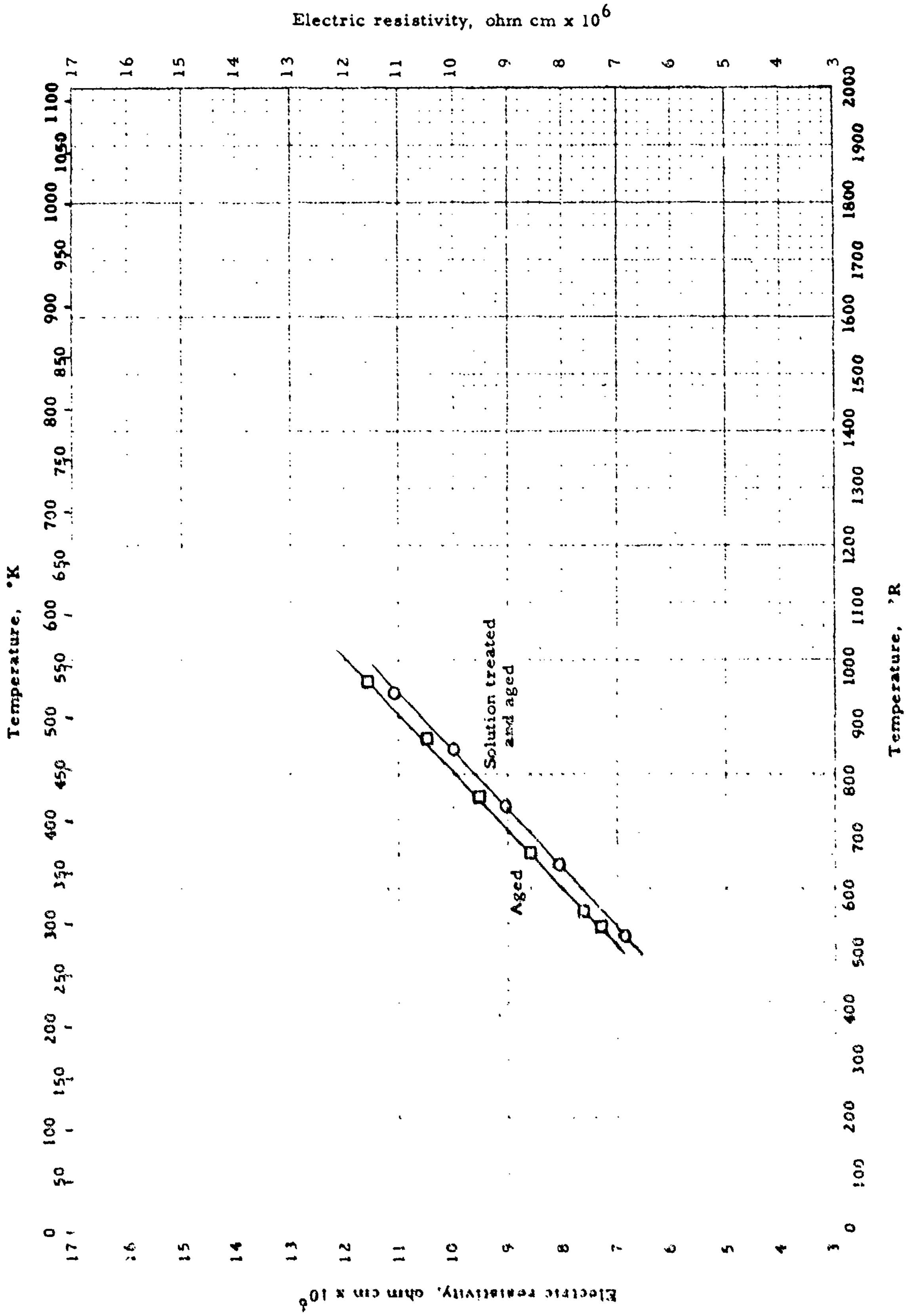


ELECTRIC RESISTIVITY -- MAGNESIUM - RARE EARTHS + X
Alloy EK-30A

ELECTRIC RESISTIVITY -- MAGNESIUM + RARE EARTHS + X
Alloy EK-30A

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G. S. Couling, S. L. et. al.	56-22	538-987	3.15% Rare Earths; 0.24% Zr; 0.066% Mn; <0.03% Al; <0.02% Zn, <0.01% ea. Cu, Si, Sn; 0.002% ea. Ca, Fe; < 0.001 % ea. Ni Pb	Kelvin double bridge	As fabricated Avg. values for 2 samples plotted. Max. dev. from mean 0.42%
□	Ibid.	56-22	538-988	Same as above	Same as above	Solution heat treated; avg. values for 2 samples plotted. Max. dev. from mean 1.25%
◇	Ibid.	56-22	536-988	Same as above	Same as above	Solution heat treated then aged. Avg. values for 2 samples plotted. Max. dev. from mean 0.6%
△	Baker, H.	57-54	528-960	3.6% Rare Earths, 0.35% Zr	Kelvin double bridge Sample in silicone fluid	Cast; temper, T_6; solution heat treated, aged

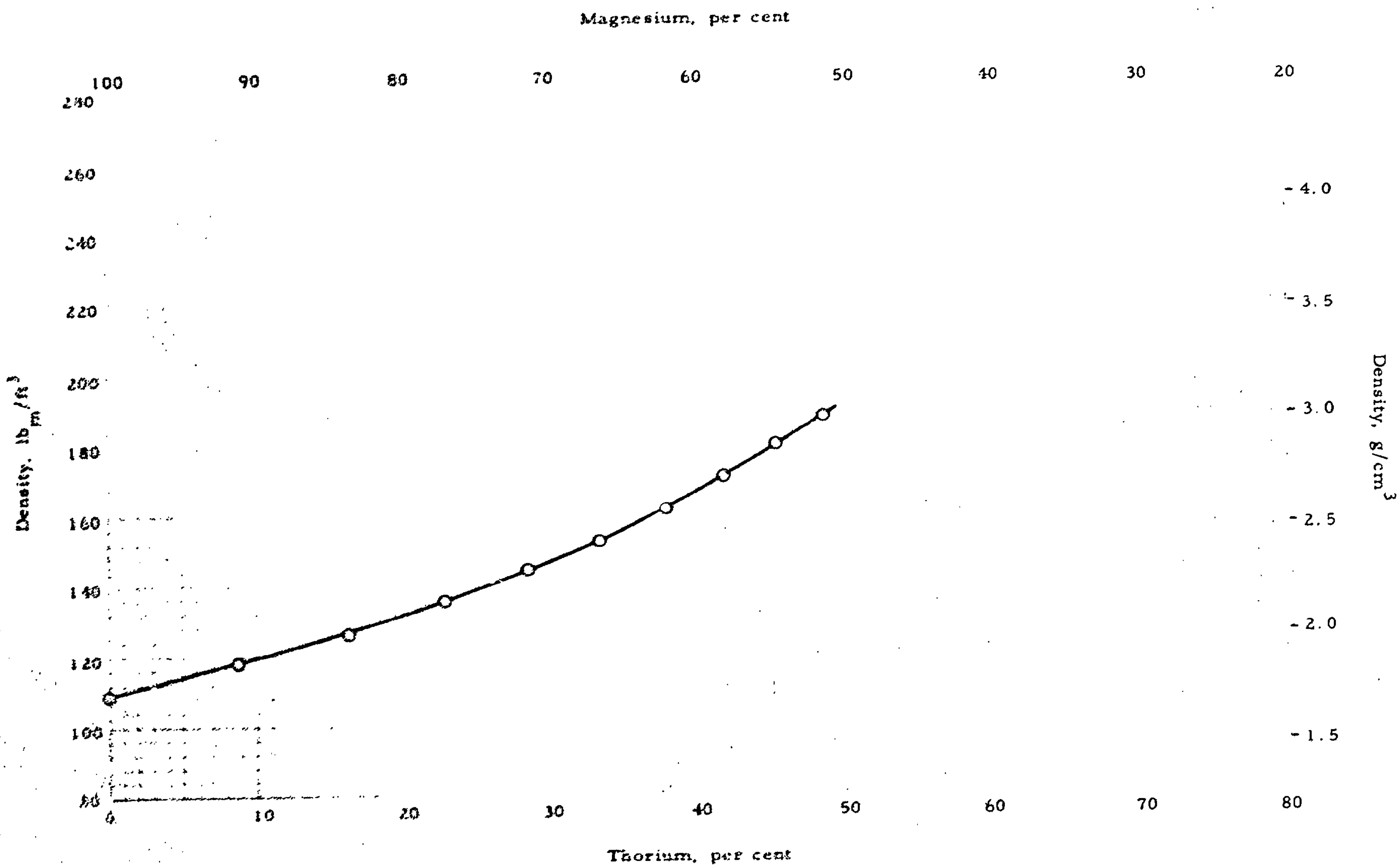


ELECTRIC RESISTIVITY -- MAGNESIUM + RARE EARTHS + X
Alloy EK-41A

ELECTRIC RESISTIVITY -- MAGNESIUM + RARE EARTHS + X
Alloy EK-41A

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Baker, H.	57-54	528-960	4.0% total rare earths; 0.55% Zr	Kelvin double bridge. Sample in heated silicone fluid	Cast. Temper T5 - aged
□	Ibid.	57-54	528-960	Same as above	Same as above	Cast. Temper T5; solution heat treated and aged



DENSITY -- MAGNESIUM + THORIUM

DENSITY -- MAGNESIUM + THORIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Leontis, T. E.	52-	Room	0 - 49% Th	Not given	

PROPERTIES OF MAGNESIUM + THORIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 3% Th	116 lb_m/ft^3	1.86 g/cm^3
Melting Point 3% Th . .	1550 °R	860 °K
Heat of Fusion 3% Th . .	140 Btu/lb_m	80 cal/g
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3
○	116	1.86

Melting Point:

	°R	°K
○	1550	861
△	1580	878
▽	1590	878

Heat of Fusion:

	Btu/lb_m	cal/g
○	140 ± 4	78 ± 2
△	142 ± 4	79 ± 2
▽	148 ± 4	82 ± 2

Heat of Vaporization:

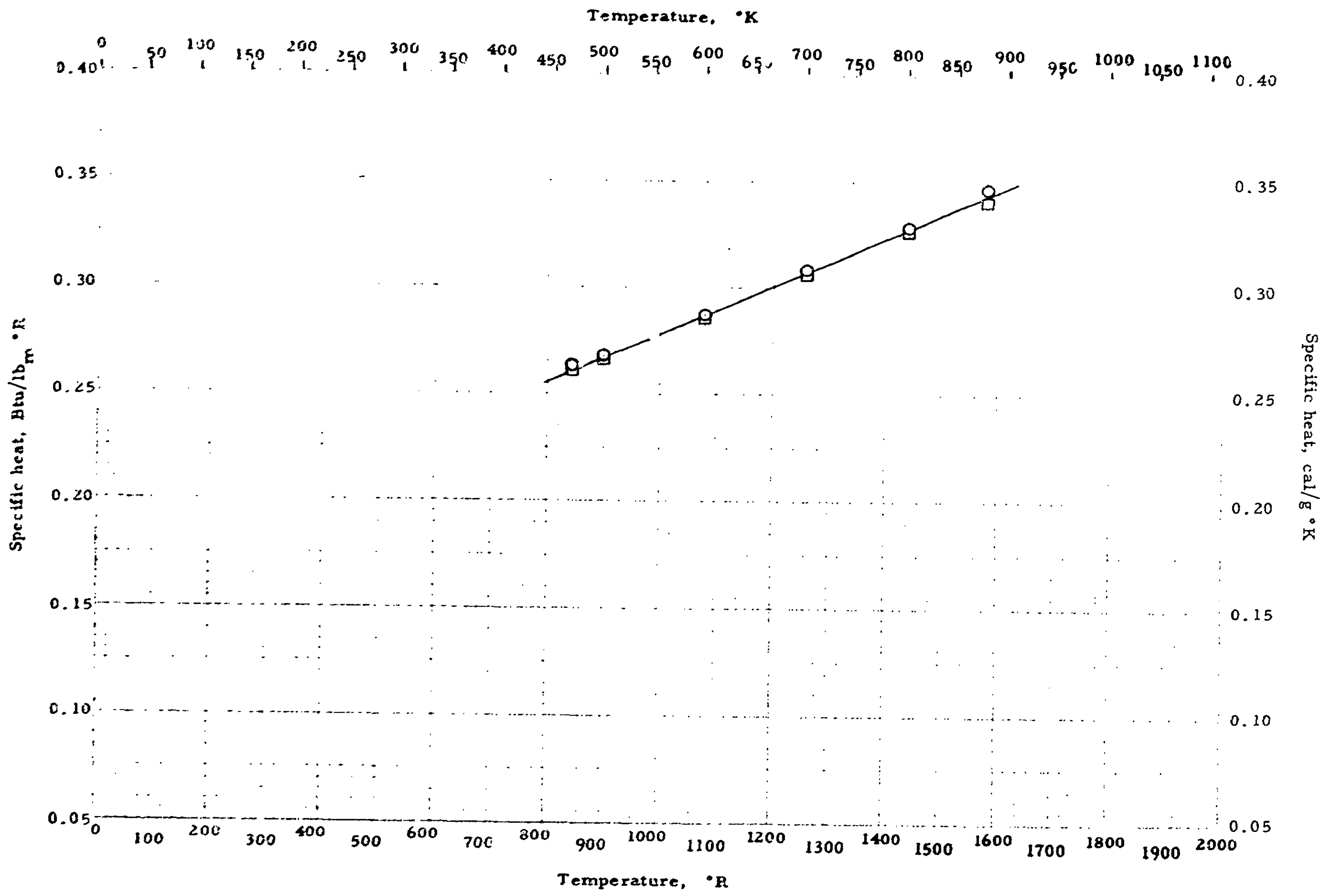
Btu/lb_m	cal/g

Heat of Sublimation:

Btu/lb_m	cal/g

REFERENCE INFORMATION

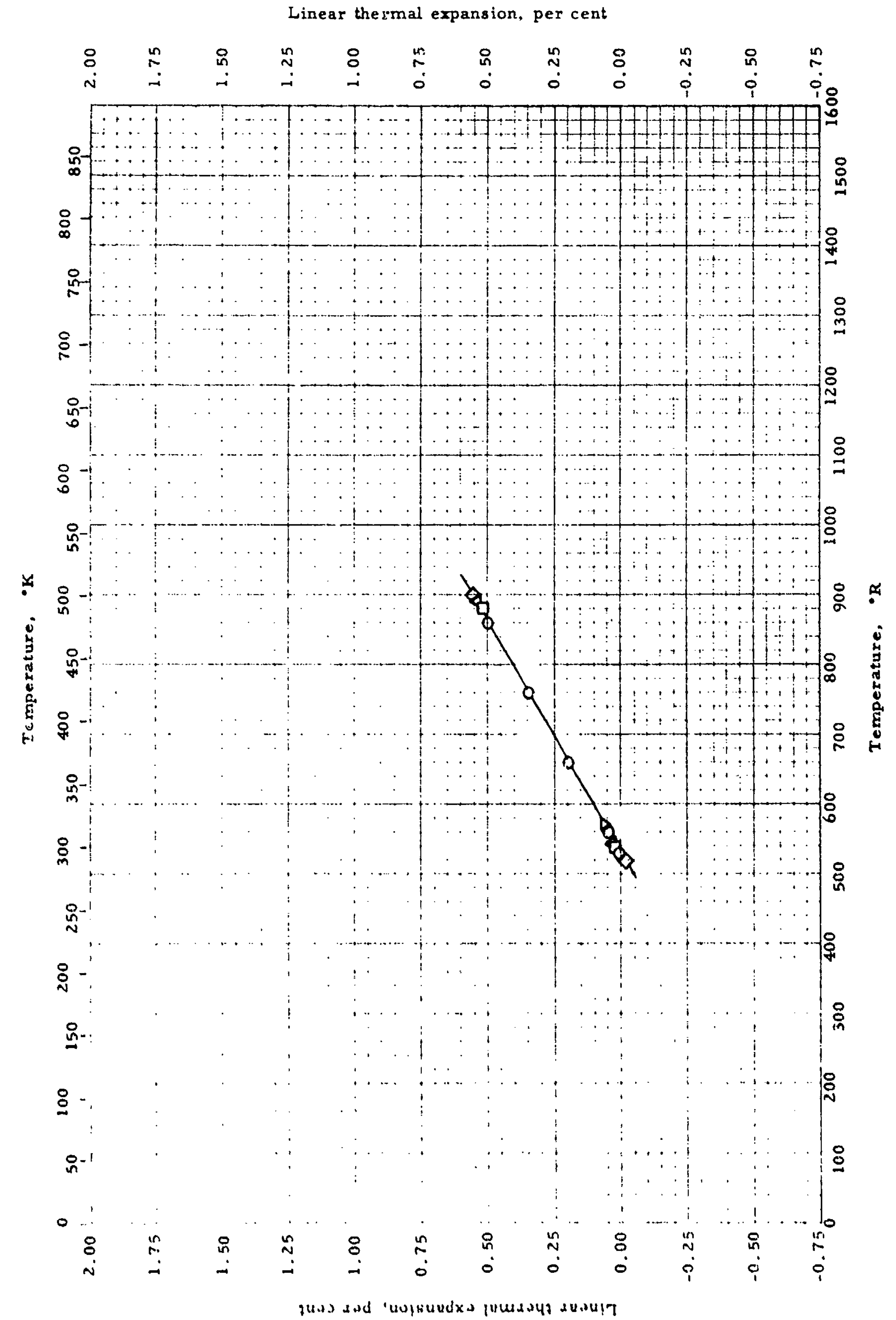
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Baker, H.	57-54	1550 1550	Mg alloy HK 31 A 3.0% Th; 0.7% Zr; < 0.08% Mn; < 0.03% Al; < 0.02% Zn; < 0.01% ea Ca, Si, Sn; ≤ 0.006% Fe; < 0.005% Cu; < 0.001% ea. Ni, Pb	ΔH_f: not given MP: not given	
△	Ibid.	57-54	1580 1560	Mg alloy HM 31 XA 1.93 to 3.28% Th; < 0.05% Zn; < 0.03% Al; ≤ 0.02% Fe; < 0.01% ea Ca, Si, Sn; < 0.005% Cu, < 0.001% Ni; < 0.001% Pb	ΔH_f: not given MP: not given	
▽	Ibid.	57-54	1580 1580	Mg alloy HM21 XA 2.0% Th; 0.5% Mn; < 0.03% Al; ≤ 0.02% Fe; < 0.01% ea. Si, Sn, Ca; < 0.005% Cu; < 0.001% ea. Ni, Pb	ΔH_f: not given MP: not given	
▢	Leontis, T. E.	52-91	Room (537°R)	3% Th	ρ: not given	Auth. reports values of ρ for 0 - 49% Th. See separate unit with graph of ρ versus composition



SPECIFIC HEAT -- MAGNESIUM + THORIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Baker, H.	57-54	846-1580	Mg Alloy HM 21 XA; 2.0% Th; 0.5% Mn	Drop method; calorimeter not described	
□	Ibid.	57-54	846-1580	Mg Alloy HK 31 A; 96.3% Mg; 3.0% Th; 0.7% Zr	Same as above	

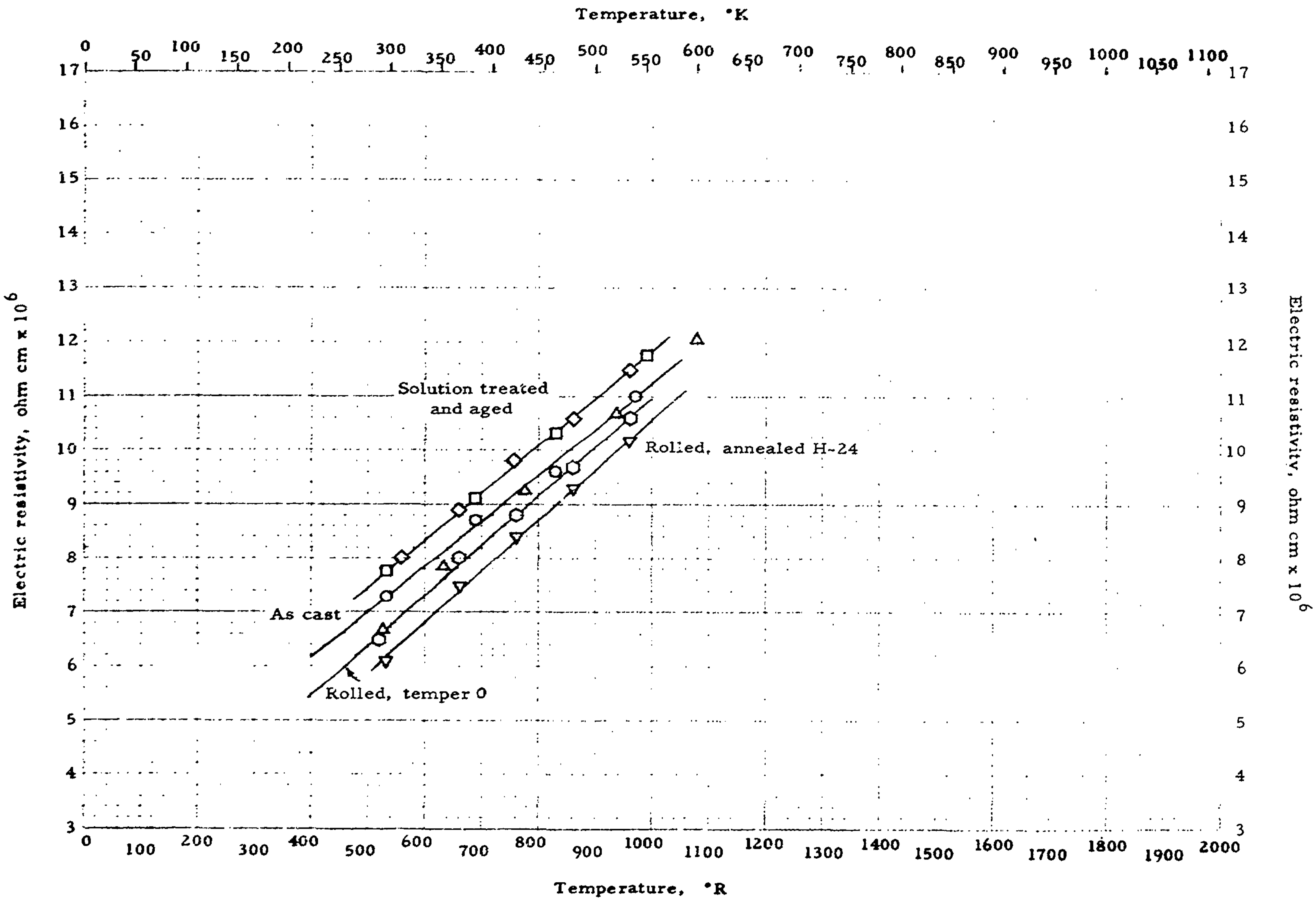


LINEAR THERMAL EXPANSION -- MAGNESIUM + THORIUM + X

LINEAR THERMAL EXPANSION -- MAGNESIUM + THORIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dow Chemical Co.	54-11	528-860	Mg Alloy HK 31 (Cast), nominal: 2.5-4.0% Th; 0.5-1.0% Zr; 0.3% others	Bollenrath type comparative dilatometer (Chronin standard)	Solution heat-treated and aged. Expansion coefficient for Chronin given as 13.9 x 10^{-6}/°C giving (14.84 + 0.12) x 10^{-6}/°F for HK 31
□	Wood, J. E.	55-40	537-879	Mg Alloy HZ 32 X A: 3.04% Th; 2.11% Zn; 0.77% Zr; 0.049% Mn; < 0.03% Al; <0.01% ea. Ca, Si, Sn; <0.005% Cu; 0.002% Fe; <0.001% ea. Ni, Pb	Bollenrath type comparative dilatometer (Chronin standard)	Cast; solution heat treated; artificially aged
△	Ibid.	55-40	537-879	Same as above	Same as above	Cast; aged
◇	Ibid.	55-40	537-879	Mg Alloy HK 31 X A: 3.16% Th; 0.71% Zr; 0.054% Mn; <0.03% Al; <0.02% Zn; <0.01% ea. Ca, Si, Sn; <0.005% Cu; 0.002% Fe; <0.001% ea. Ni, Pb	Same as above	Cast; solution heat treated; artificially aged
▽	Johnson, H. A.	54-100	528-555	Mg Alloy HK 31A: nominal: 2.5 - 4.0% Th; 0.5 - 1.0% Zr; 0.30% others max.	Electric strain gages on sample in constant temp. bath	Cast, T6 treatment. Auth. est. accuracy ± 1%

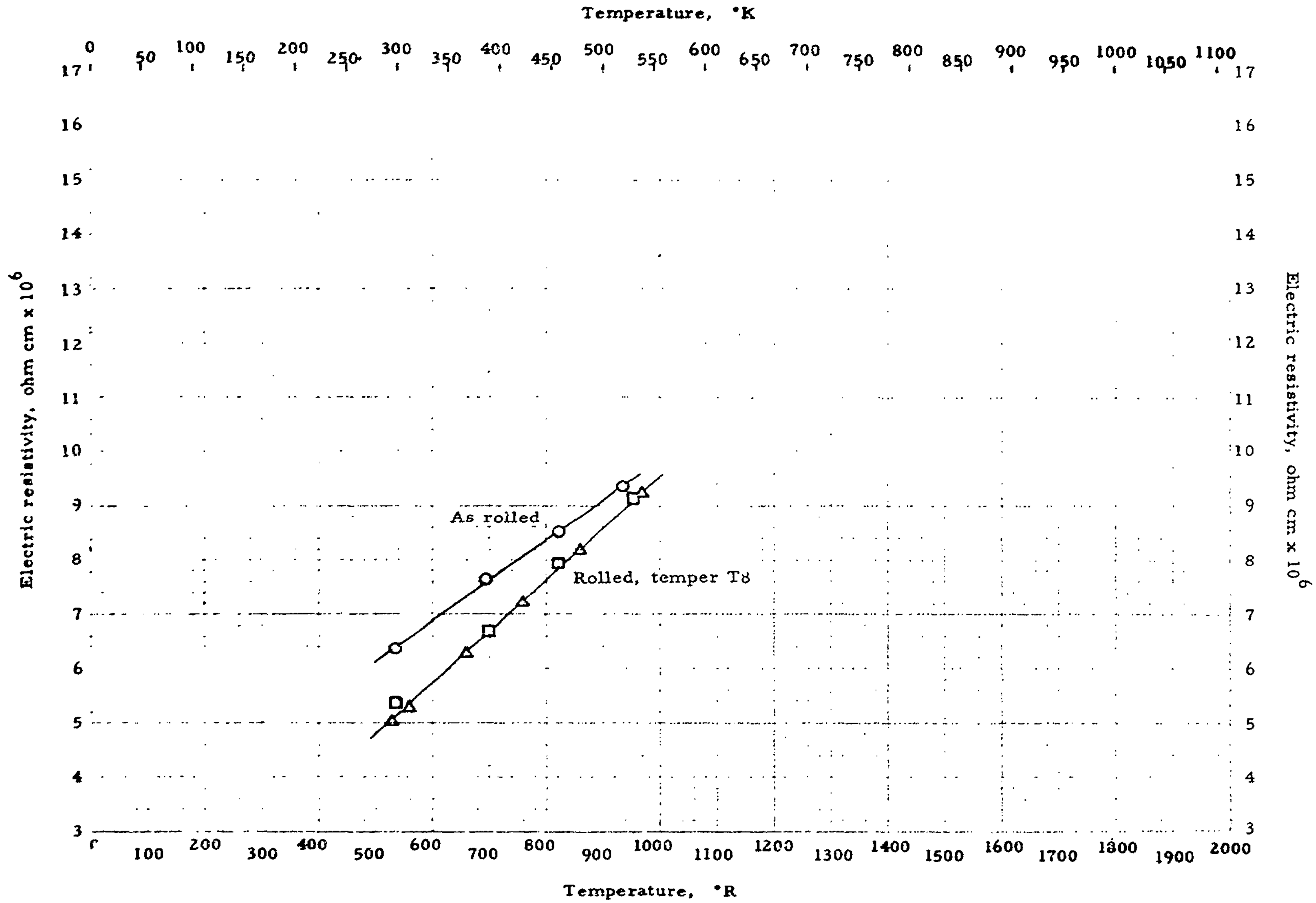


ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HK-31

ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HK-31

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G. S., Couling, S. L. et. al.	56-22	535-972	Mg alloy HK 31XA; Mg + 3.16% Th; 0.71% Zr; 0.054% Mn; <0.03% Al; <0.02% Zn; <0.01% ea. Ca, Si, Sn; <0.005% Cu; 0.002% Fe; <0.001% ea. Ni, Pb	Kelvin double bridge	As cast. Plotted points show avg. (within 2.8%) for 2 samples
□	Ibid.	56-22	535-987	Same as above	Same as above	Solution heat treated with and without aging. Plotted points show avg. (within 0.5%) for 3 samples
△	Ibid.	56-22	527-1082	Mg alloy HK 31XA; Mg + 2.77% Th; 0.62% Zr; 0.032% Mn; <0.03% Al; <0.02% Zn; <0.01% ea. Ca; Si, Sn; <0.003% Cu; 0.001% Fe; <0.001% ea. Ni; Pb	Same as above	Rolled sheet, annealed to H-24 condition
◇	Baker, H.	57-54	528-960	Magnesium alloy HK 31A ; 96.3% Mg; 3.0% Th; 0.7% Zr	Same as above	Cast, solution heat treated and aged
▽	Ibid.	57-54	528-960	Same as above	Same as above	Rolled, temper H-24
⬡	Ibid.	57-54	528-960	Same as above	Same as above	Rolled, temper O

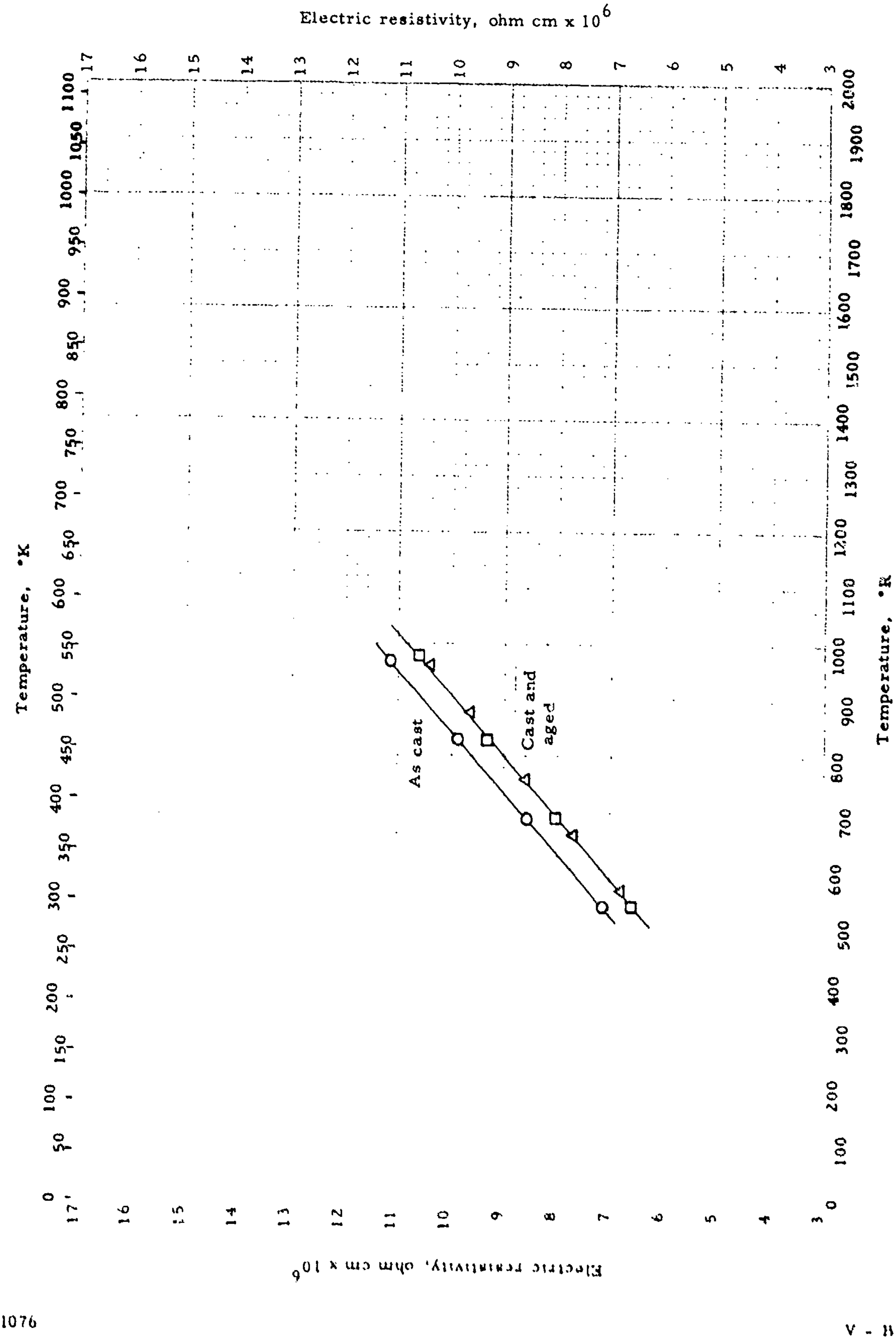


ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HM-21XA

ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HM-21XA

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G. S., Couling, S. L. et. al.	56-22	537-937	Mg alloy HM-21XA; Mg + 2.22% Th; 0.59% Mn; <0.03% Al, 0.021% Fe; <0.02% Zn; <0.01% ea. Ca; Sn; <0.005% Cu; <0.001% ea. Pb; Si; <0.0005% Ni	Kelvin double bridge	Rolled sheet as fabricated. Plotted pts. show avg. values (within 1.5%) for 6 samples
□	Ibid.	56-22	535-955	Same as above	Same as above	Rolled sheet, hard annealed. Plotted pts. show avg. (within 0.55%) for 4 samples
△	Baker, H.	57-54	528-960	Magnesium alloy HM-21XA; 97.5% Mg; 2.0% Th; 0.5% Mn	Kelvin double bridge Sample immersed in silicone fluid	Rolled, temper T8



ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HZ-32XA

ELECTRIC RESISTIVITY -- MAGNESIUM + THORIUM + X
Alloy HZ-32XA

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Foerster, G. S., Couling, S. L., Baker, H. et al.	56-22	535-971	Alloy HZ-32XA, Mg + 3.04% Th; 2.11% Zn; 0.77% Zr, 0.049% Mn; <0.03% Al; <0.01% ea. Ca, Si, Sn; <0.005% Cu; <0.002% Fe; <0.001% ea. Ni, Pb	Kelvin double bridge	As cast. Plotted points show avg. (within 1%) for 2 samples
□	Ibid.	56-22	535-979	Same as above	Same as above	Cast and aged. Plotted points show avg. (within 1%) for 2 samples
△	Baker, H.	57-54	526-960	Magnesium Alloy HZ32A 94.2% Mg; 3.0% Th; 2.1% Zn; 0.7% Zr	Kelvin double bridge. Sample in silicone fluid	Cast, temper T5 aged

Symbol	Material Composition, % Mg	Zn	MM	Melting Point °R	°K
O	93.78	6.22	0.00	1116	617
	93.01	6.39	0.60	1320	733
	92.53	6.31	1.16	1355	753
	91.99	6.31	1.70	1382	768
	91.51	6.26	2.23	1400	778
	90.41	6.31	3.28	1420	789
	88.37	6.29	5.34	1440	800
	86.46	6.22	7.32	1440	800

MELTING POINTS OF MAGNESIUM + ZINC + MISCHMETAL

MELTING POINTS OF MAGNESIUM + ZINC + MISCHMETAL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Dow Chemical Co.	54-11	1064-1460	Ternary alloy series, Mg + 6% Zn; 0 - 7% MM	MP: metallographic inspection for signs of chilled liquid in sample quenched from various temperature levels	Authors' smoothed values. Mischmetal contains approx. 50% Ce, 50% La

PROPERTIES OF MAGNESIUM + ZINC + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 6% Zn . .	1110°R	620°K
Heat of Fusion 6% Zn .	140 Btu/lb_m	76 cal/g
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			

		°R	°K
Melting Point:			
	○	1427	793
	□	1110	617

		Btu/lb_m	cal/g
Heat of Fusion:			
	○	137 ± 7	76 ± 4

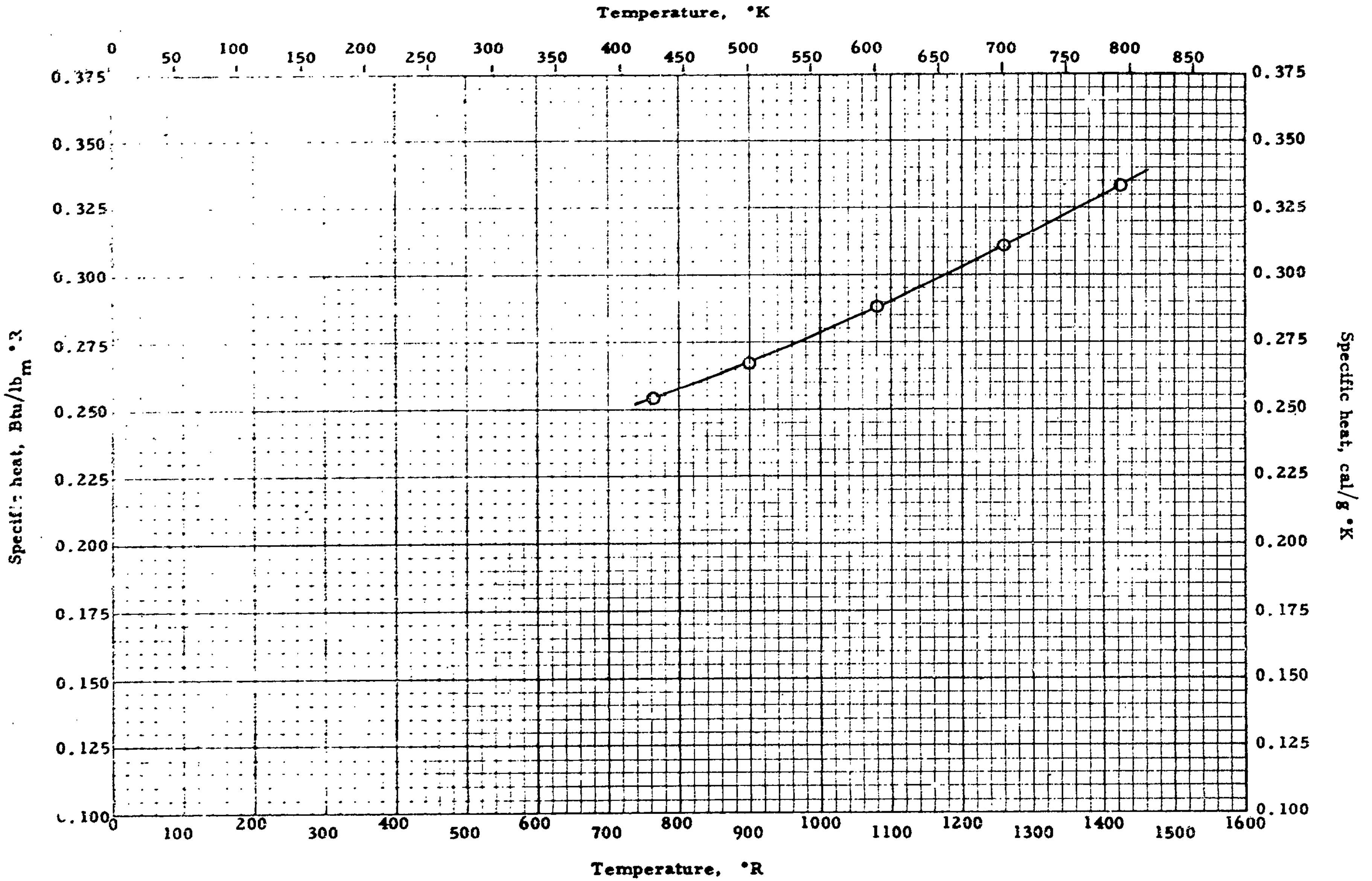
		Btu/lb_m	cal/g
Heat of Vaporization:			

		Btu/lb_m	cal/g
Heat of Sublimation:			

PROPERTIES OF MAGNESIUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Baker, H.	57-54	1427	93.40% Mg; 5.78% Zn; 0.74% Zr; 0.05% Mn; 0.03% Al. Alloy ZK60	ΔH_f: difference of liquid and solid enthalpy at MP MP: not given	
□	Dow Chemical Co.	54-11	1110	93.78% Mg; 6.22% Zn	MP: metallographic inspection for signs of chilled liquid in sample quenched from various temp. levels	

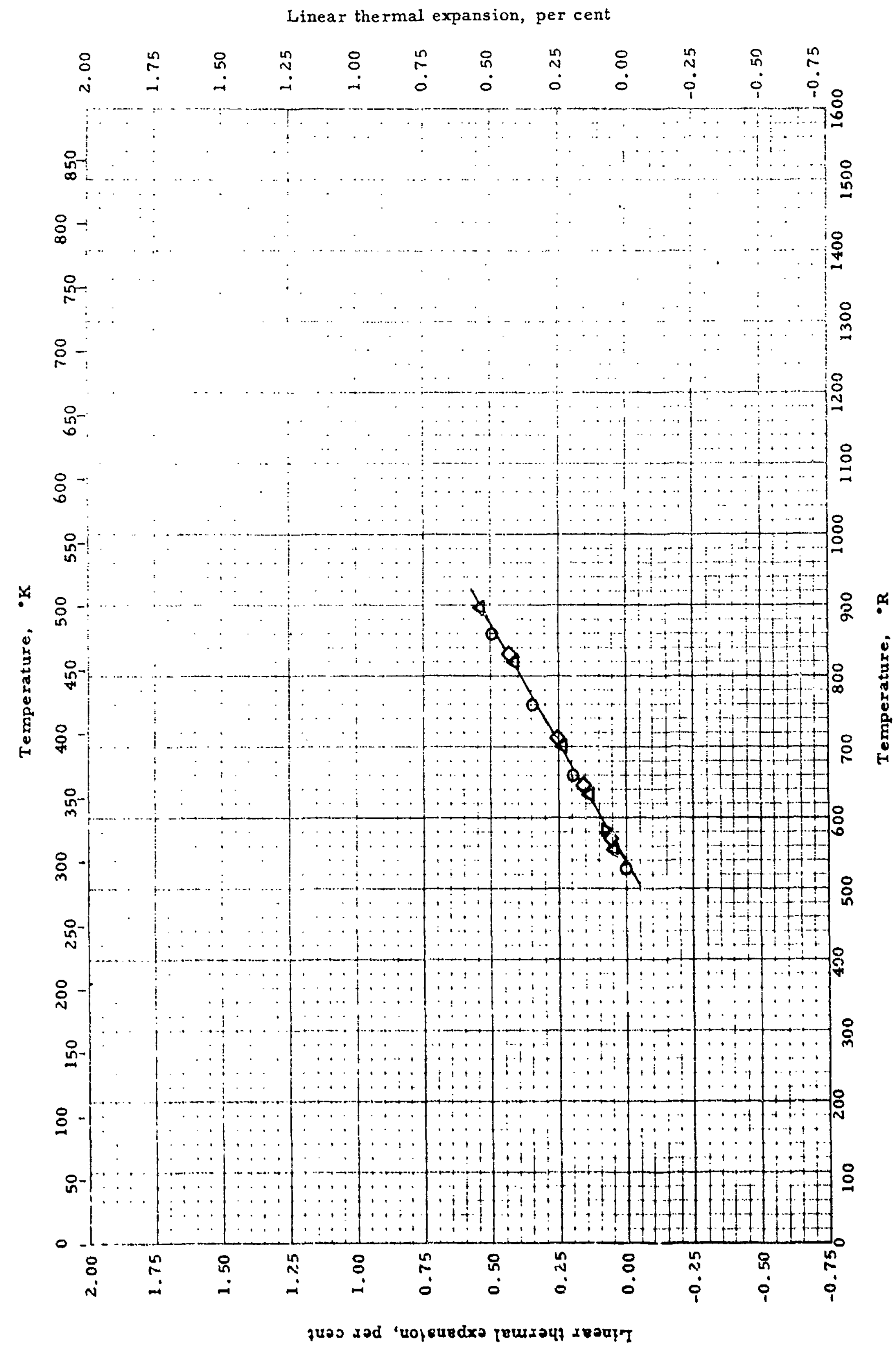


SPECIFIC HEAT -- MAGNESIUM + ZINC + X

SPECIFIC HEAT -- MAGNESIUM + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Baker, H.	57-54	425-793	Mg Alloy ZK 60 A; 5.78% Zn; 0.74% Zr; 0.05% Mn; 0.03% Al	Drop method; calorimeter not described	

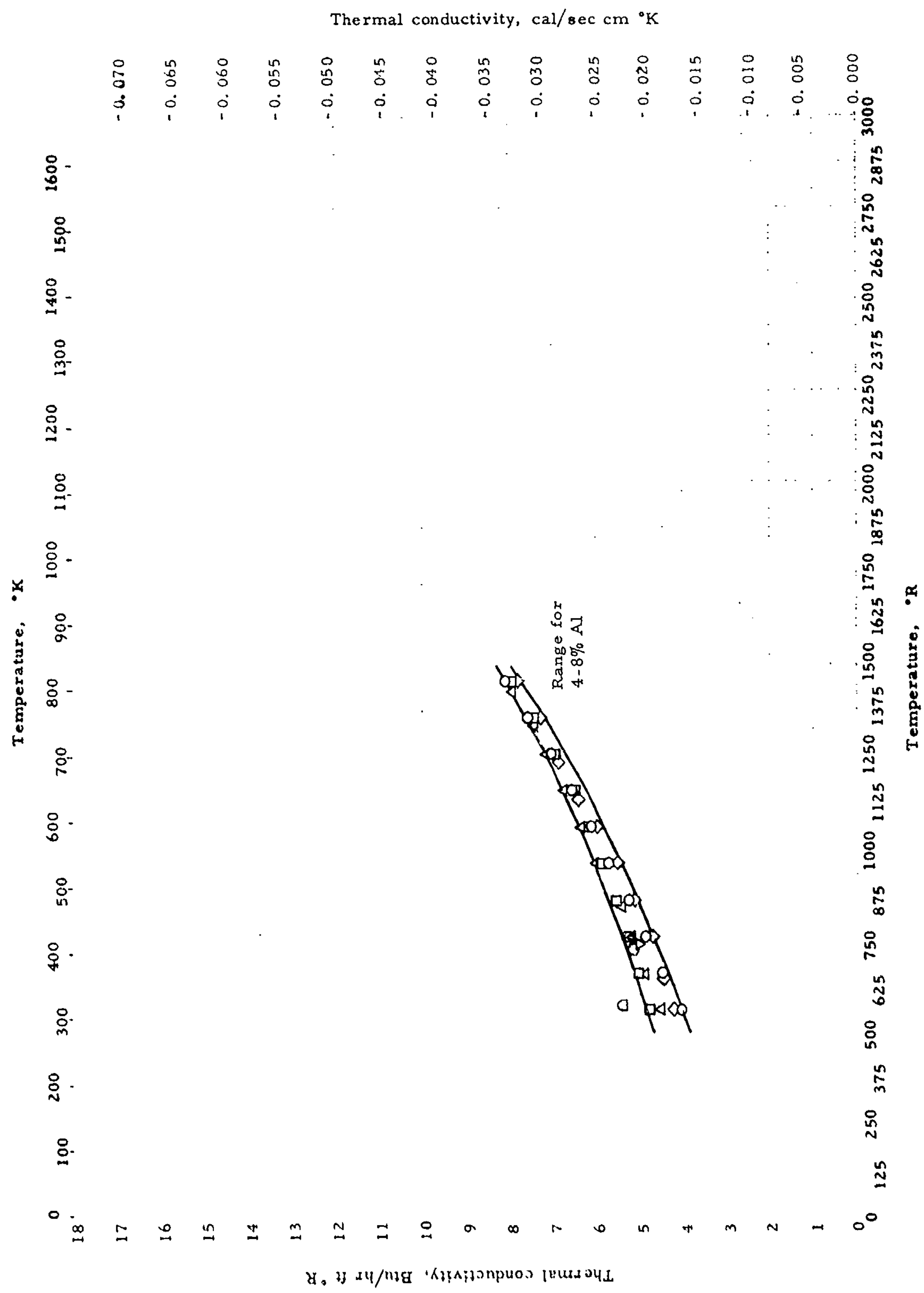


LINEAR THERMAL EXPANSION -- MAGNESIUM + ZINC + X
4-7% Zn (ZK 60A)

LINEAR THERMAL EXPANSION -- MAGNESIUM + ZINC + X
4-7% Zn (ZK 60A)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wood, G.E.	55-40	537-880	Mg alloy ZK60A (Ingot Extruded); 5.78% Zn; 0.74% Zr; 0.048% Mn; 0.03 % Al; <0.01 ea. Ca, Si, Sn; <0.001 ea. Cu, Fe, Ni, Pb	Bollenrath type comparative dilatometer (Chronin standard)	Expansion coefficient for chronin given as 13.9 x $10^{-6}/°C$ giving (14.72 + 0.08) x $10^{-6}/°F$ for ZK60A
△	Ibid.	55-40	537-880	Mg alloy ZK60A (pellet extruded); 5.3% Zn; 0.69% Zr; 0.046% Mn; <0.03Al; <0.01 ea. Ca, Si, Sn; 0.006 Pb; 0.001 ea. Ca, Fe, Ni	Same as above	Longitudinal. Auth. gives expansion coeff. as (13.83 ± 0.19) x $10^{-6}/°F$
◇	Ibid.	55-40	537-880	Same as above	Same as above	Transverse. Auth. gives expansion coeff. as (13.84 ± 0.29) x $10^{-6}/°F$
▽	Johnson, H.A.	54-100	528-555	Mg Alloy ZK 60A. nominal: 4.8 - 6.2% Zn; 0.45% Zr min.; 0.3% others max.	Electric strain gages on sample in constant temp. bath	Extruded, TS condition, held 24 hr. at 300°F. Auth. est. accuracy ± 1%

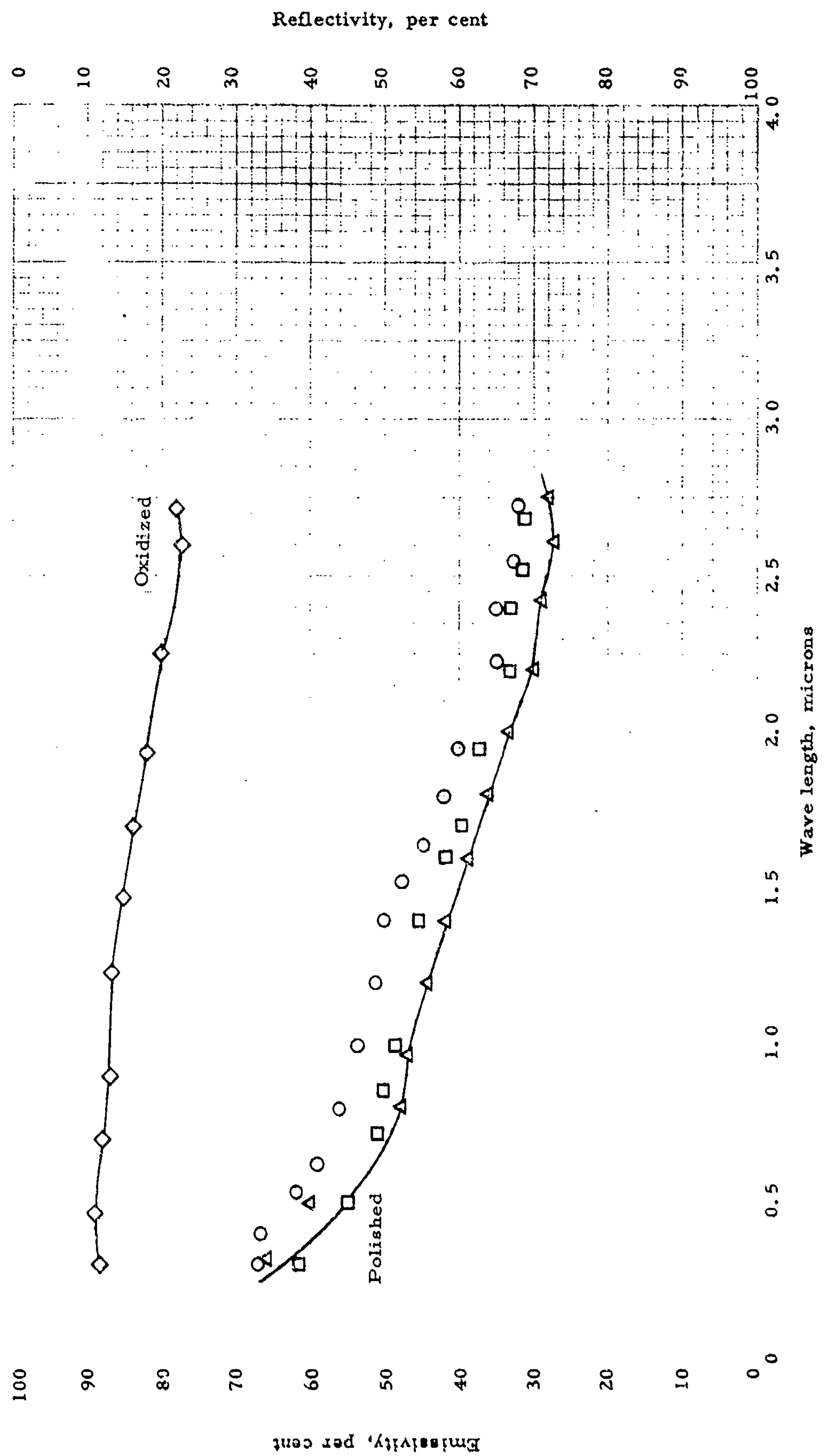


THERMAL CONDUCTIVITY -- TITANIUM + ALUMINUM + X

THERMAL CONDUCTIVITY -- TITANIUM + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W. Wood, W. D. and Lucks, C. F.	58-21	560-1460	C-130 AM, formerly RC-130B. Nominal: 4% Al; 4% Mn	Comparative; rods	Armco Iron Standard. Auth. est. accuracy ± 5%
□	Ibid.	58-21	560-1460	Ti-155A Nominal: 5% Al; 1.5% Fe; 1.4% Cr; 1.2% Mo	Same as above	Same as above
△	Ibid.	58-21	560-1460	A-110AT. Nominal: 5% Al; 2.5% Sn	Same as above	Same as above
◇	Ibid.	58-21	560-1460	Ti-6Al-4V. Nominal: 6% Al; 4% V	Same as above	Same as above
▽	Smith, K. F. and Chiswik, H. H.	56-113	734	7% Al; 0.5% Si	Meas. on comparison apparatus heated by NaK bath	
⬡	Ibid.	56-113	725	7% Al	Same as above	
⌂	Argonne Natl. Laboratory	54-115	571	8% Al	Not given	

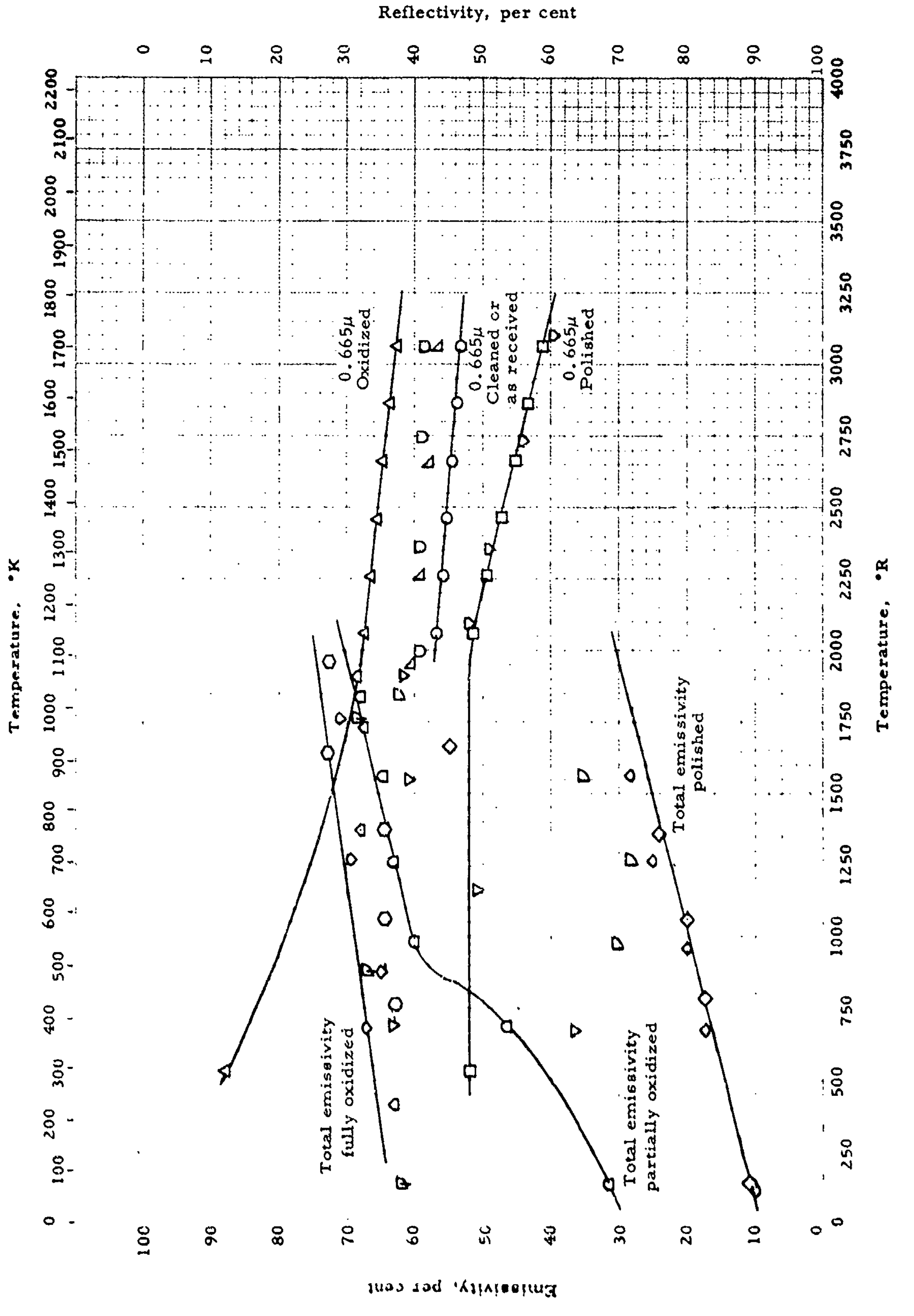


SPECTRAL EMISSIVITY -- TITANIUM + ALUMINUM + VANADIUM

SPECTRAL EMISSIVITY -- TITANIUM + ALUMINUM + VANADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Olson, O.H., and Morris, J.C.	58-1	Room	6% Al; 4% V	Spectral reflectivity at 9°; sample compared with $MgCO_3$ standard in MgO integrating sphere; quartz lens, PbS detector	As received
□	Ibid.	58-1	Room	Same as above	Same as above	Detergent cleaned
△	Ibid.	58-1	Room	Same as above	Same as above	Polished
◇	Ibid.	58-1	Room	Same as above	Same as above	Oxidized 30 min. at red heat in air



EMISSIVITY -- TITANIUM + ALUMINUM + X

EMISSIVITY -- TITANIUM + ALUMINUM + X

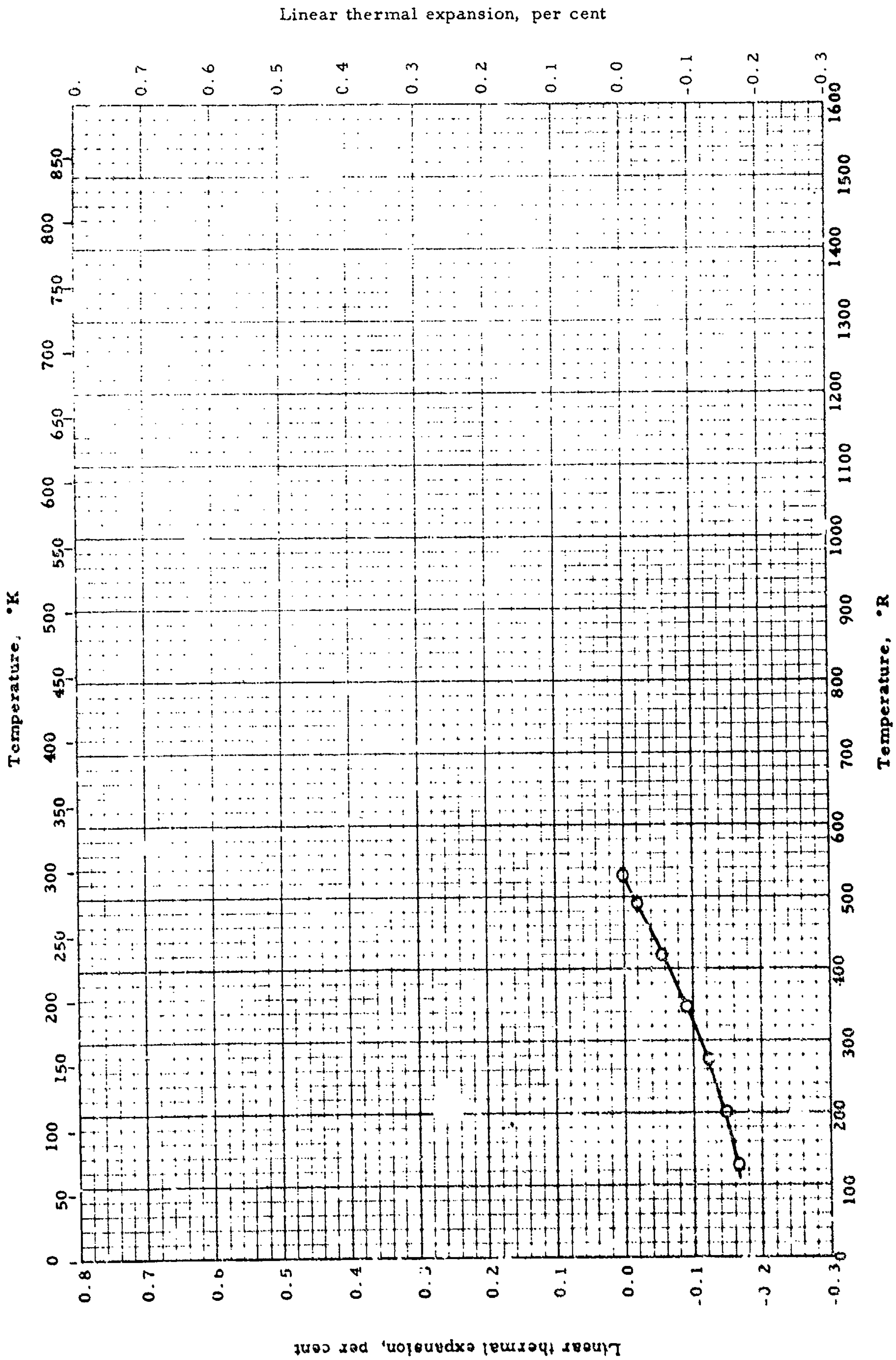
REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H. et al.	57-8	2060-3060	90% Ti, 6% Al, 4% V	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	Surface as received, and detergent cleaned
□	Ibid.	57-8	2060-3060	Same as above	Same as above	Polished
△	Ibid.	57-8	2060-3060	Same as above	Same as above	Oxidized 30 min. at red heat in air
◇	Olson, O.H. and Morris, J.C.	58-1	140-1660	Same as above	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer; sample temp. by Cu-Const thermocouple	Polished
▽	Ibid.	58-1	6[illegible]-1915	Same as above	Same as above	Polished: cycle 2 heating
○	Ibid.	58-[illegible]	768-1955	Same as above	Same as above	Polished; cycle 3 heating
○	Ibid	58-1	135-1835	Same as above	Same as above	Oxidized 30 min. at red heat in air, cycle 1 heating
△	Ibid	58-1	135-1835	Same as above	Same as above	Oxidized; cycle 2 heating
◇	Ibid.	58-1	135-1835	Same as above	Same as above	Oxidized: cycle 3 heating
○	Ibid.	58-1	135-1835	Same as above	Same as above	Oxidized: cycle 3 cooling
▽	Betz, H. T., Olson, O.H. et al.	57-8	[illegible]960-3060	Titanium Alloy A-110-AT; nominal: 5% Al; 2.5% Sn	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer, sample temp. by thermocouple	As received and cleaned by detergent
□	Ibid.	57-8	2060-3060	Same as above	Same as above	Polished
△	Ibid.	57-8	[illegible]960-3060	Same as above	Same as above	Oxidized 30 min. at red heat in air
◇	Olson, O.H. and Morris, J.C.	58-[illegible]	135-1960	Titanium Alloy A-110-AT; nominal: 5% Al; 2.5% Sn	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Polished

EMISSIVITY -- TITANIUM + ALUMINUM + X (Cont d)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
	Olson, O.H. and Morris, J.C.	58 .	535-3060	Titanium Alloy A-110-AT, nominal: 5% Al; 2.5% Sn	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	Oxidized 30 mn. at red heat in air
	Ibid.	58-1	535-1960	Same as above	Same as above	Oxidized 30 min. at red heat in air, cycled 3 times to 1750°R, cooling

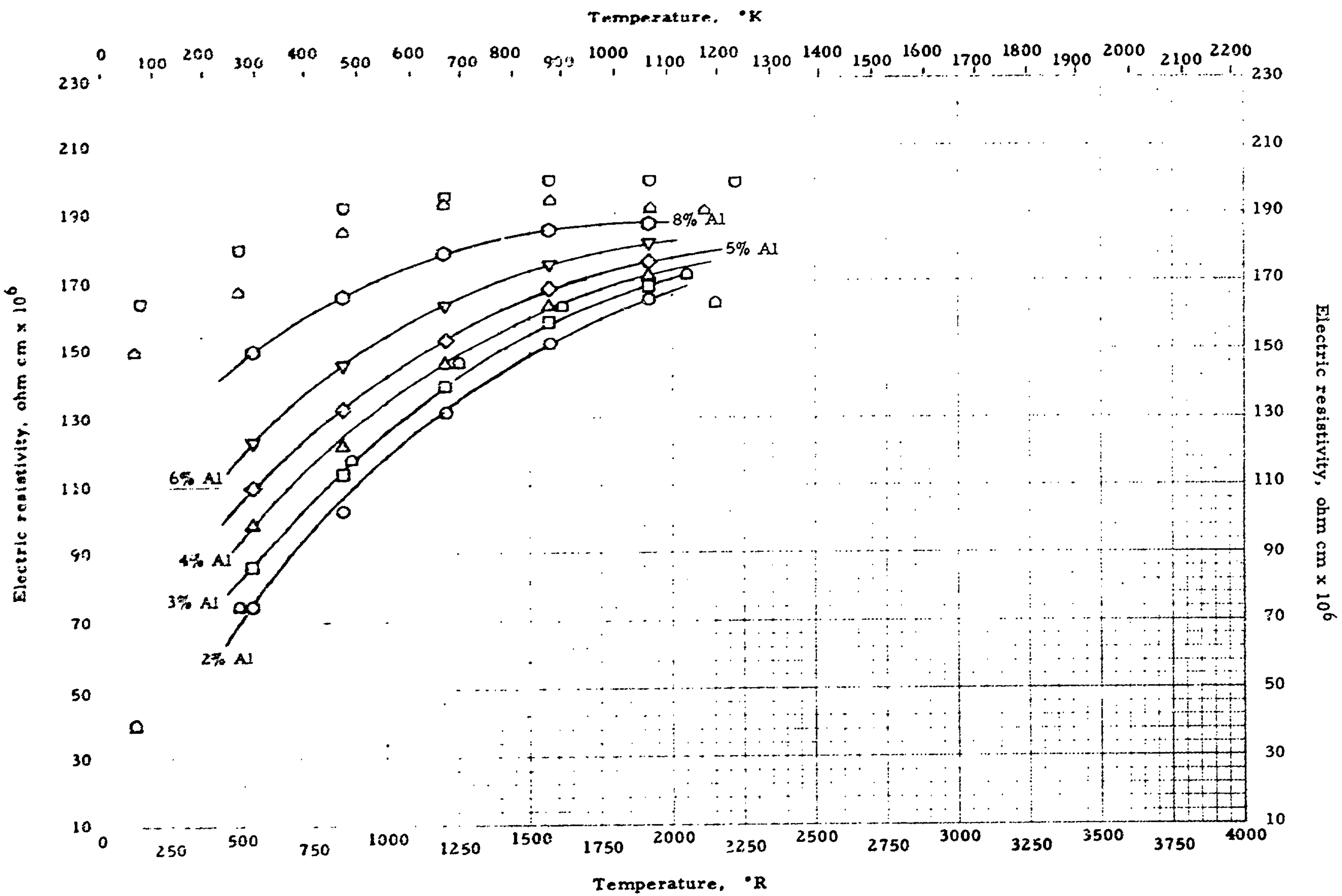


LINEAR THERMAL EXPANSION -- TITANIUM + ALUMINUM + X

LINEAR THERMAL EXPANSION -- TITANIUM + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bishop, S. M., Spretnak, J. W. and Fontana, M. G.	52-122	130-530	Ti-150-A: 3.8% Al; 3.8% Mn; 0.24% C	Quartz dilatometer with dial gauge. Temp. by thermocouple	Annealed 6 hr. at 1200°F

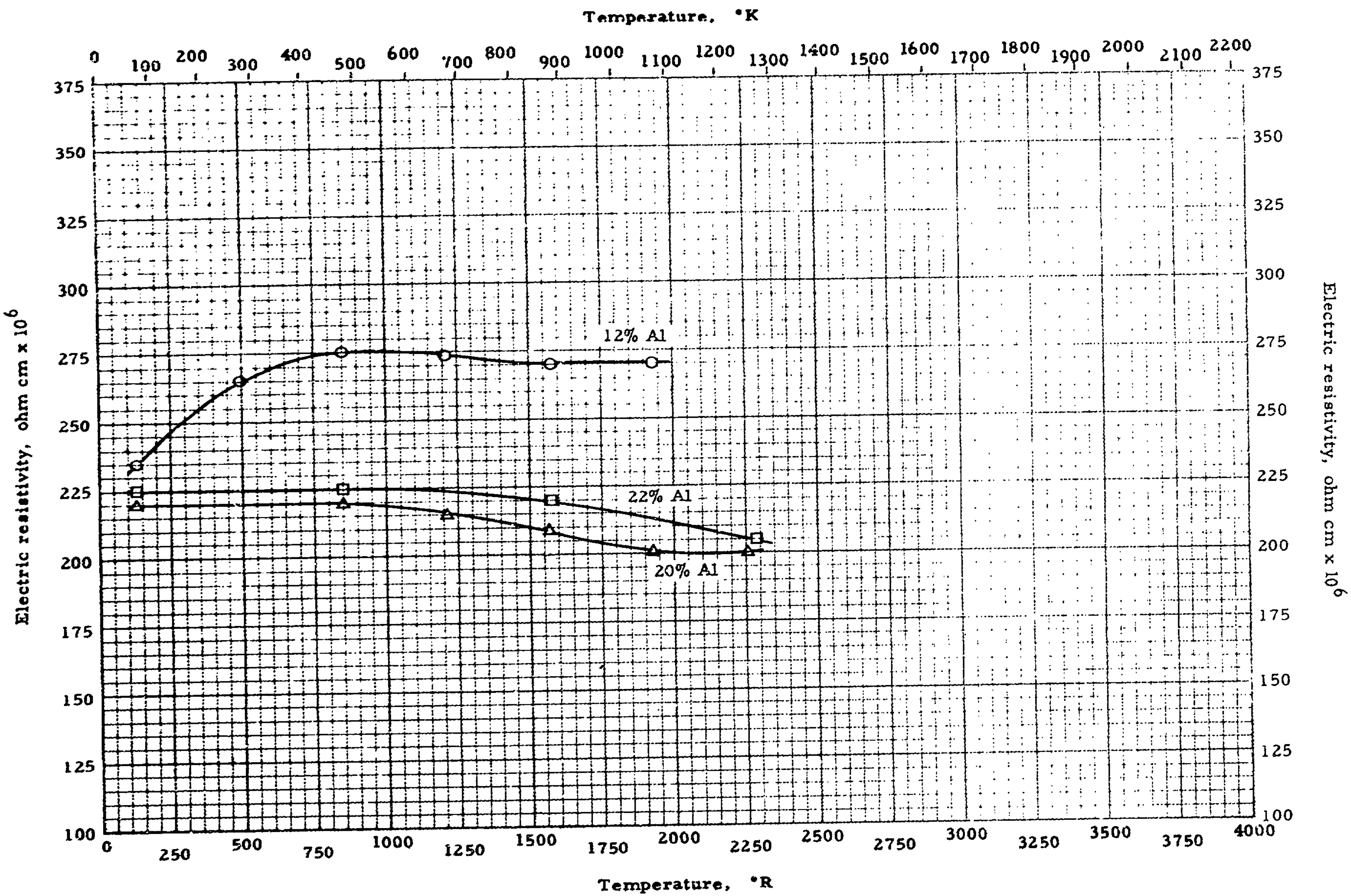


ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM
(0 - 10% Al)

ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM
(0 - 10% Al)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S. L. and McQuillan, A. D.	56-15	537-1932	Ti, α-phase; 2% Al	Double balance bridge	High temp. work in vacuum of 10^{-6} mm Hg. Auth. est. accuracy 1%
□	Ibid.	56-15	537-1932	Ti, α-phase; 3% Al	Same as above	Same as above
△	Ibid.	56-15	537-1932	Ti, α-phase; 4% Al	Same as above	Same as above
◇	Ibid.	56-15	537-1932	Ti, α-phase; 5% Al	Same as above	Same as above
▽	Ibid.	56-15	537-1932	Ti, α-phase; 6% Al	Same as above	Same as above
○	Ibid.	56-15	537-1932	Ti, α-phase; 8% Al	Same as above	Same as above
◠	Munster, A. Sagel, K. and Zwicker, U.	56-112 also 56-96	150-2148	1% Al	Potential drop	Made from pure iodide-titanium or 99.96% pure Mg-reduced Ti and 99.99% pure Al. Melted in arc furnace with W electrode, in 99.995% pure A atm., remelted twice more. Diff. between heating and cooling <3%
△	Ibid.	56-112 also 56-96	150-2094	7% Al	Same as above	Same as above
◡	Ibid.	56-112 also 56-96	150-2220	8% Al	Same as above	Same as above

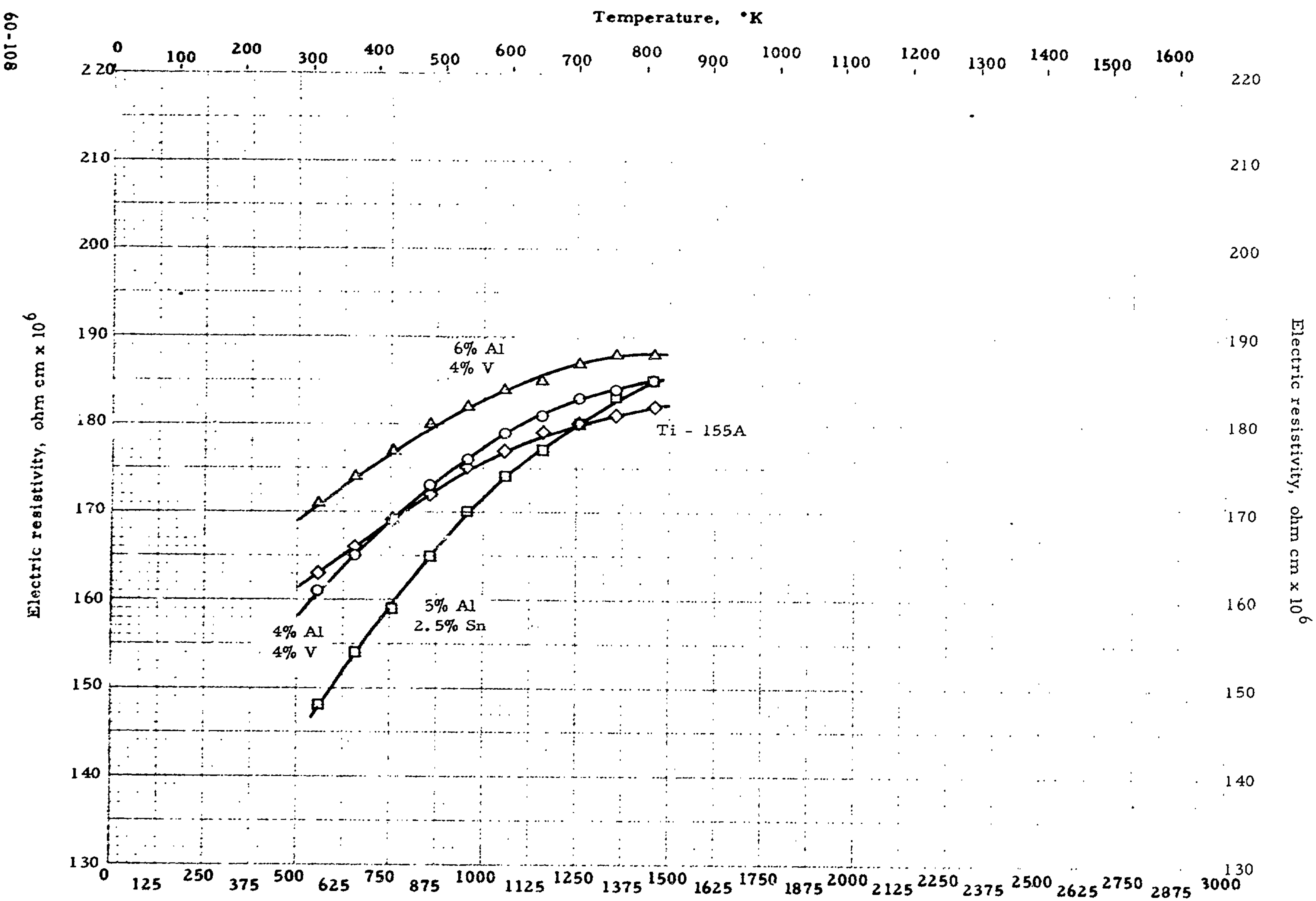


ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM
(10 - 22% Al)

ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM (10 - 22% Al)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Munster, A., Sagel, K. and Zwicker, U.	56-96 also 56-112	150-2292	12% Al	Potential drop	Prepared from iodide Ti or 99.96% pure Mg - reduced Ti and 99.99% pure Al, melted in arc furnace with W electrode in 99.995% pure A atm. and remelted twice more. Diff. between heating and cooling runs less than 3%
△	Ibid.	56-96 also 56-112	150-2004	20% Al	Same as above	Same as above
□	Ibid.	56-96 also 56-112	150-2220	22% Al	Same as above	Same as above

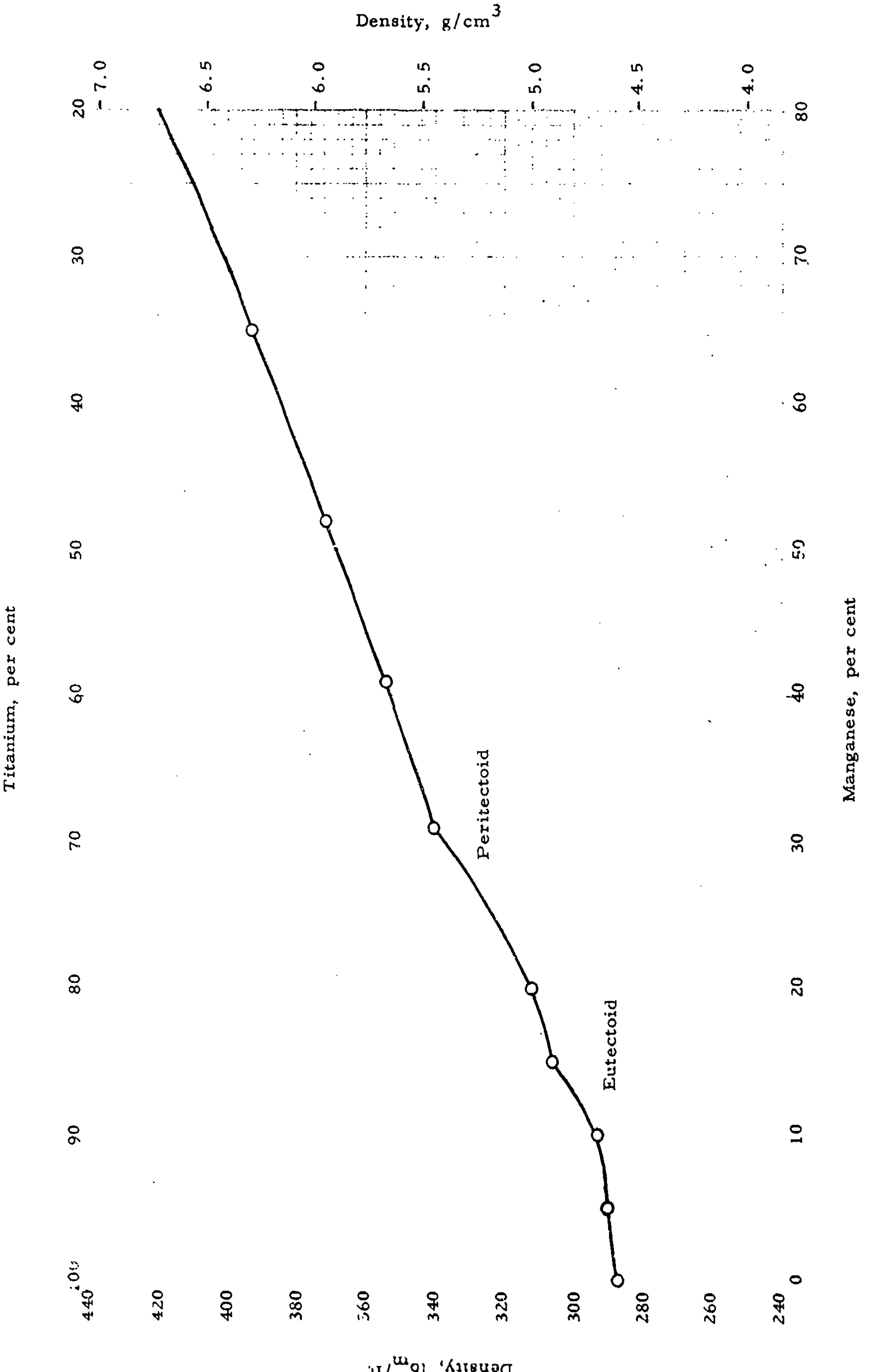


ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM + X

ELECTRIC RESISTIVITY -- TITANIUM + ALUMINUM + X

REFERENCE INFORMATION

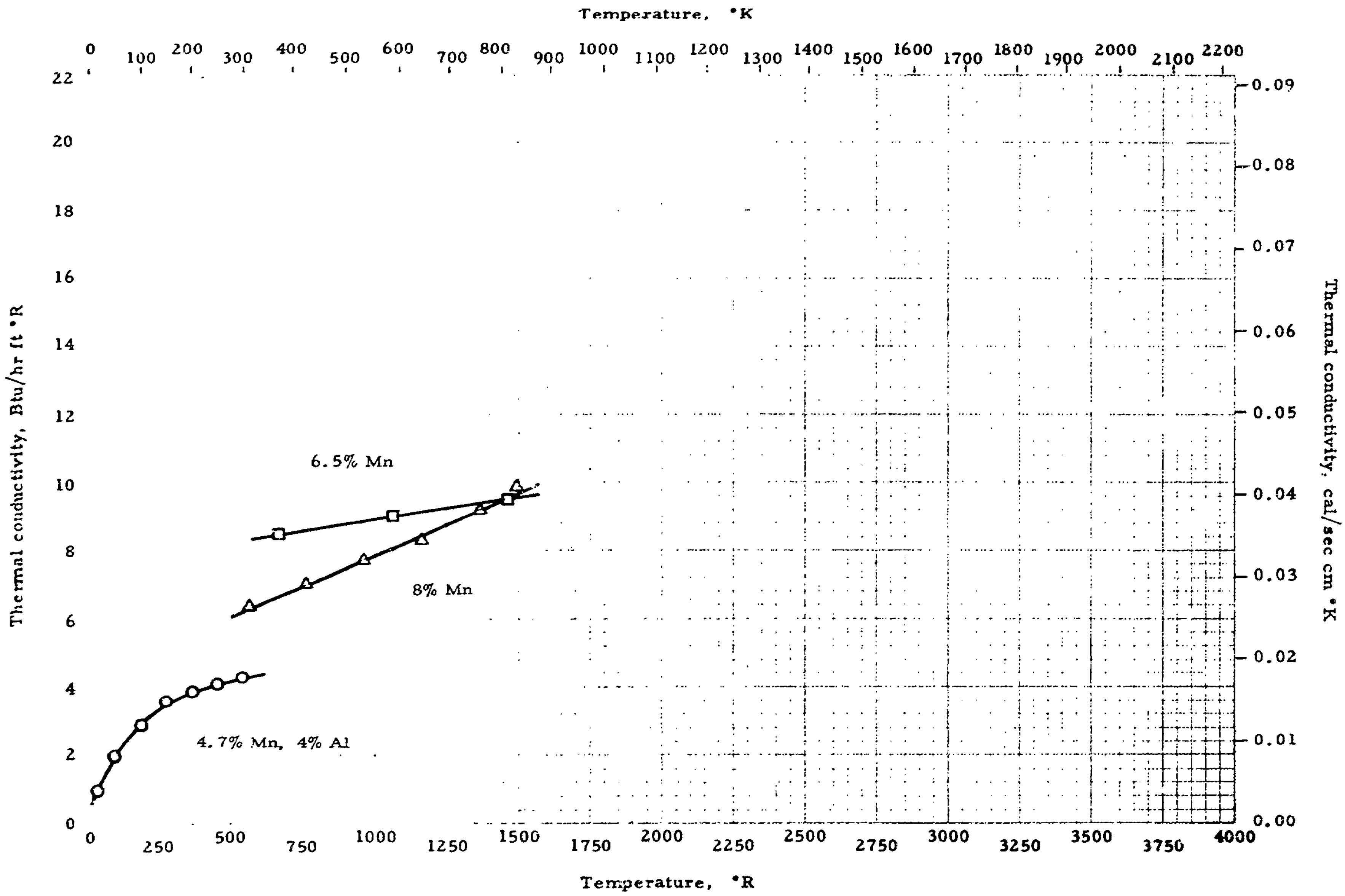
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W., Wood, W. D. and Lucks, C. F.	58-21	560-1460	C - 130 AM (Formerly RC-130B) Nominal: 4% Al; 4% Mn	Potential drop	Auth. est. accuracy ± 1%
□	Ibid	58-21	560-1460	A-110 AT Nominal: 5% Al; 2.5% Sn	Same as above	Same as above
△	Ibid	58-21	560-1460	Ti-6Al-4V Nominal: 6% Al; 4% V	Same as above	Same as above
◇	Ibid	58-21	560-1460	Ti-155A Nominal: 5% Al; 1.5% Fe; 1.4% Cr; 1.2% Mo	Same as above	Same as above



DENSITY -- TITANIUM + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mavkuth, D. J., Ogden, H. R. et. al.	54-57	Room	Alloy series 0-65% Mn.	ρ: Weight in air and in water	Also see Mn + Ti Alloys

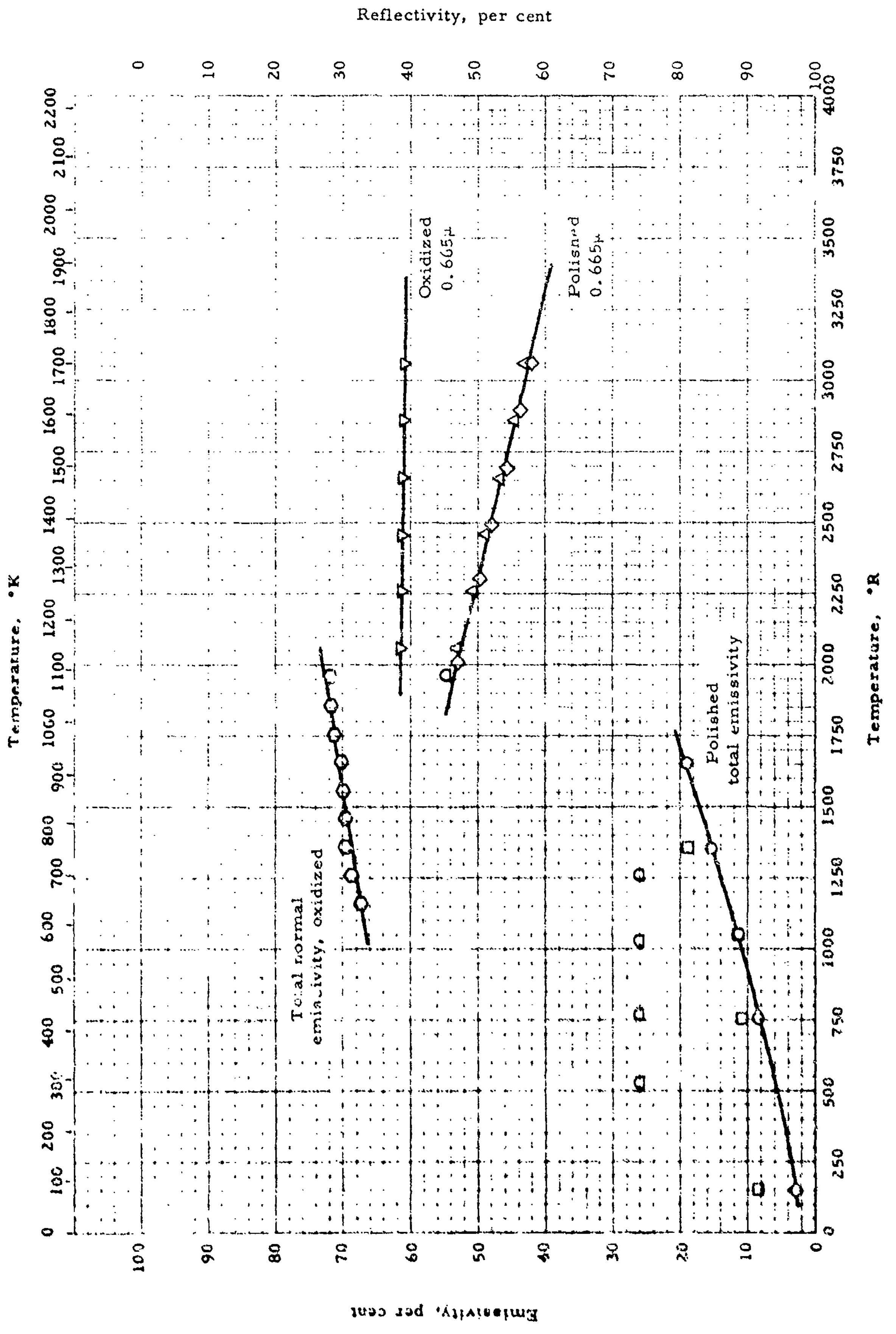


THERMAL CONDUCTIVITY -- TITANIUM + MANGANESE + X

THERMAL CONDUCTIVITY -- TITANIUM + MANGANESE + X

REFERENCE INFORMATION

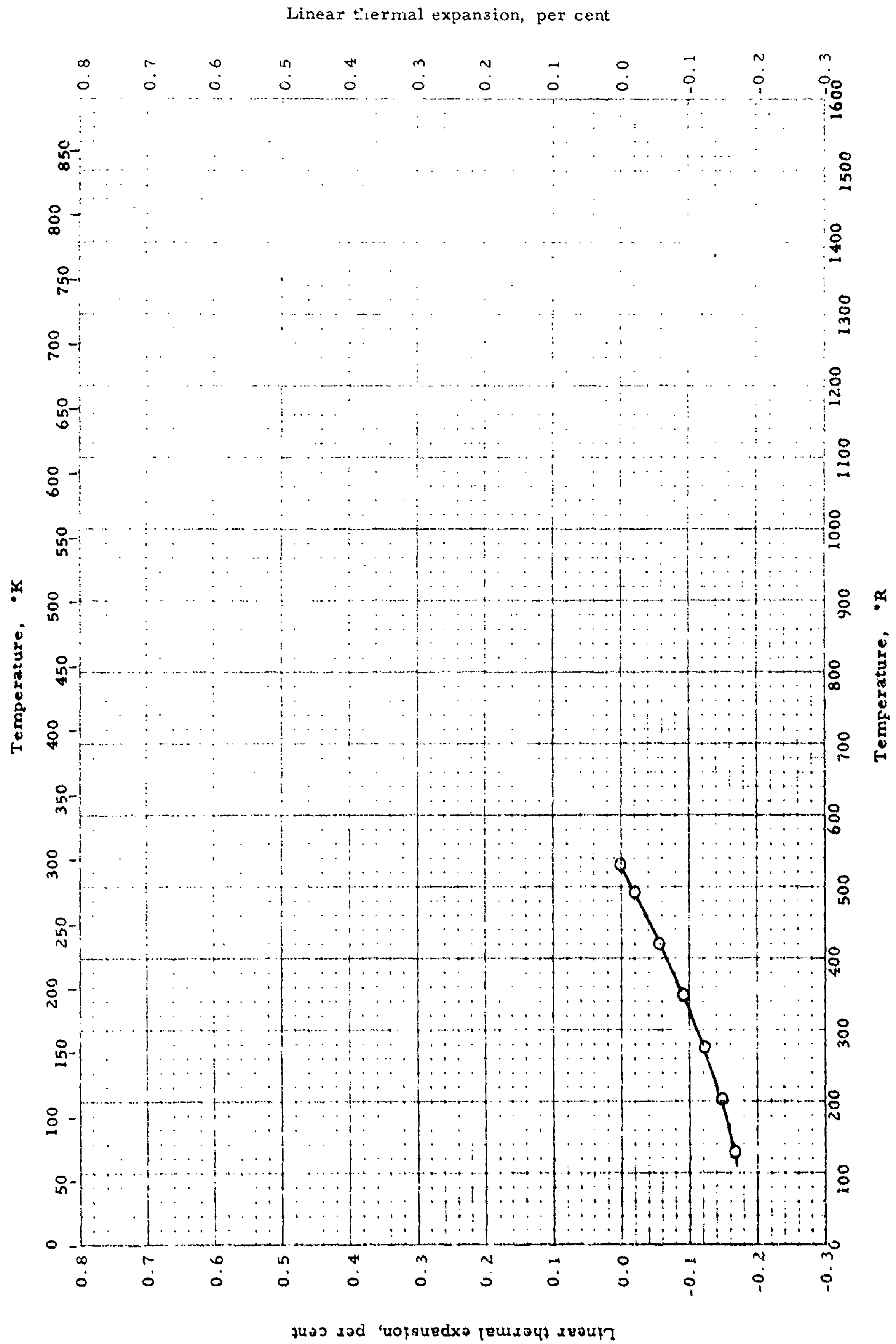
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Tyler, W. W., Nesbitt, L. B. and Wilson Jr., A. C.	53-38	36-540	Ti Alloy RC-130 B; 4.7% Mn; 3.99% Al; 0.14% C	Axial heat flow in rod; guarded heat source and sample	Auth. est. accuracy ± 10%
□	Loewen, E. G.	56-21	660-1460	93.21% Ti; 6.50% Mn; 0.20% Fe; 0.177% O; 0.05% C; 0.034% N; 0.0069% H	Axial heat flow in rod; calorimeter sink	
△	Deem, H. W., Wood, W. D. and Lucks, C. F.	58-21	560-1460	C-110M (Formerly RC-130A); nominal: 8% Mn	Comparative; rods, Armco Iron Standard	Auth. est. accuracy ± 5%



EMISSIVITY -- TITANIUM + MANGANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Betz, H. T., Olson, O. H. et al.	57-8	150-1660	Titanium Alloy C110M, nominal: 8% Mn	Total normal emissivity: comparative: radiant heat flow compared with that of a black body, thermistor bolometer	3 surface conditions: as received, cleaned by detergent, polished
□	Ibid.	57-8	150-1660	Same as above	Same as above	Oxidized 30 min. at red heat in air
△	Ibid.	57-8	2060-3060	Same as above	Spectral normal emissivity at 0.665μ: comparative: surface brightness compared with that of a black body hole, disappearing filament optical pyrometer; sample temp. by thermocouple	As received and cleaned by detergent
◇	Ibid.	57-8	2060-3060	Same as above	Same as above	Polished
▽	Ibid.	57-8	2060-3060	Same as above	Same as above	Oxidized 30 min. at red heat in air
○	Wade, W. R.	58-20	[illegible]60-1960	Ti Alloy RS-120 Nominal 7% Mn	Total normal and hemispherical emissivity. Radiant heat measured with thermopile, calibrated with black body	Oxidized 75 min. at 1500°F. Total normal equals total hemispherical emissivity for this sample
○	Ibid.	58-20	537-1960	Same as above	Same as above	Polished. Total normal equals total hemispherical emissivity for this sample

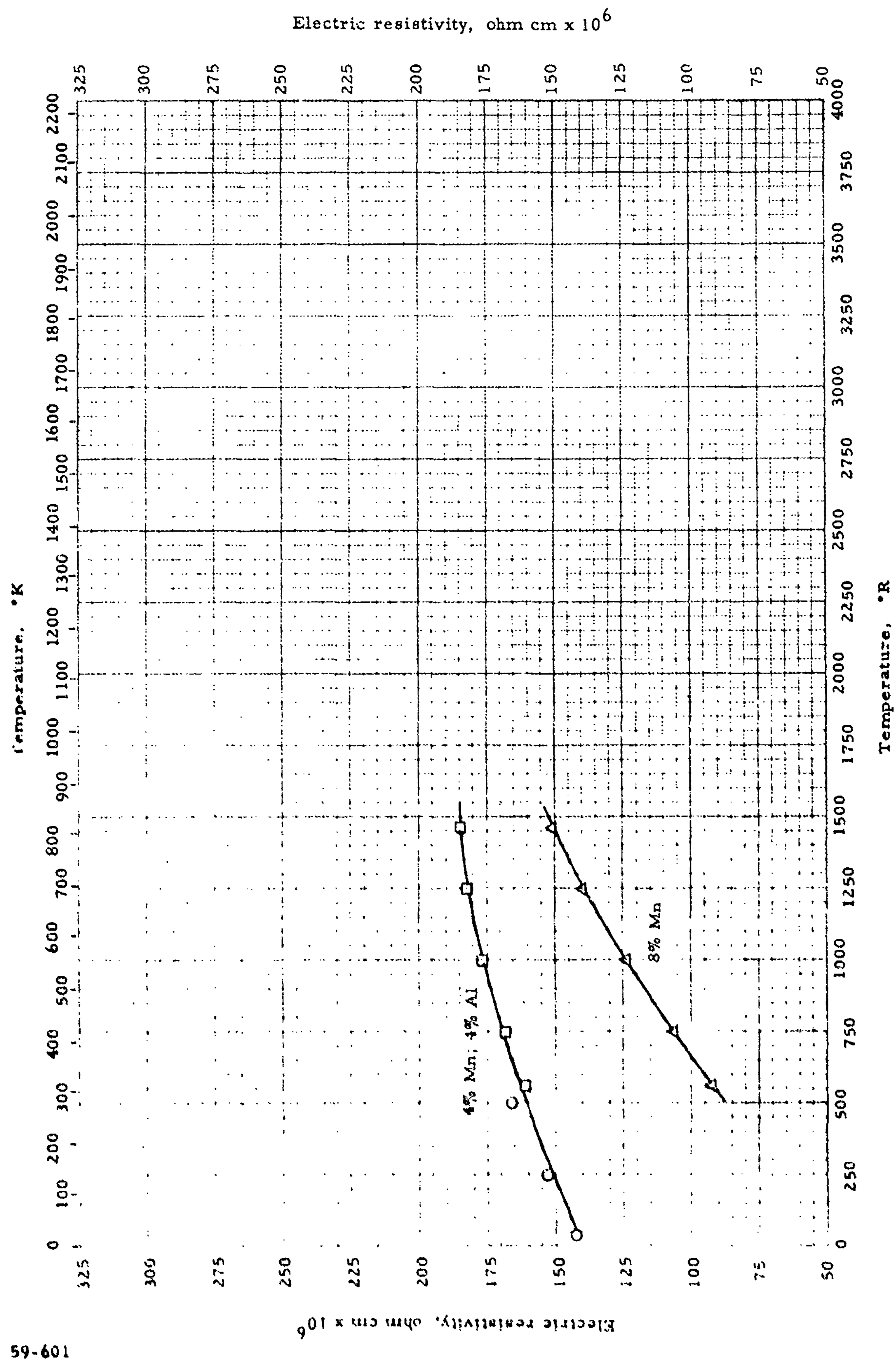


LINEAR THERMAL EXPANSION -- TITANIUM + MANGANESE + X

LINEAR THERMAL EXPANSION -- TITANIUM + MANGANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bishop, S. M., Spretnak, J. W. and Fontana, M. G.	52-122	130-530	Ti-150-A. 3.8% Mn; 3.8% Al; 0.24% C	Quartz tube dilatometer with dial gauge. Temp. by thermocouple	Annealed 6 hr. at 1200°F

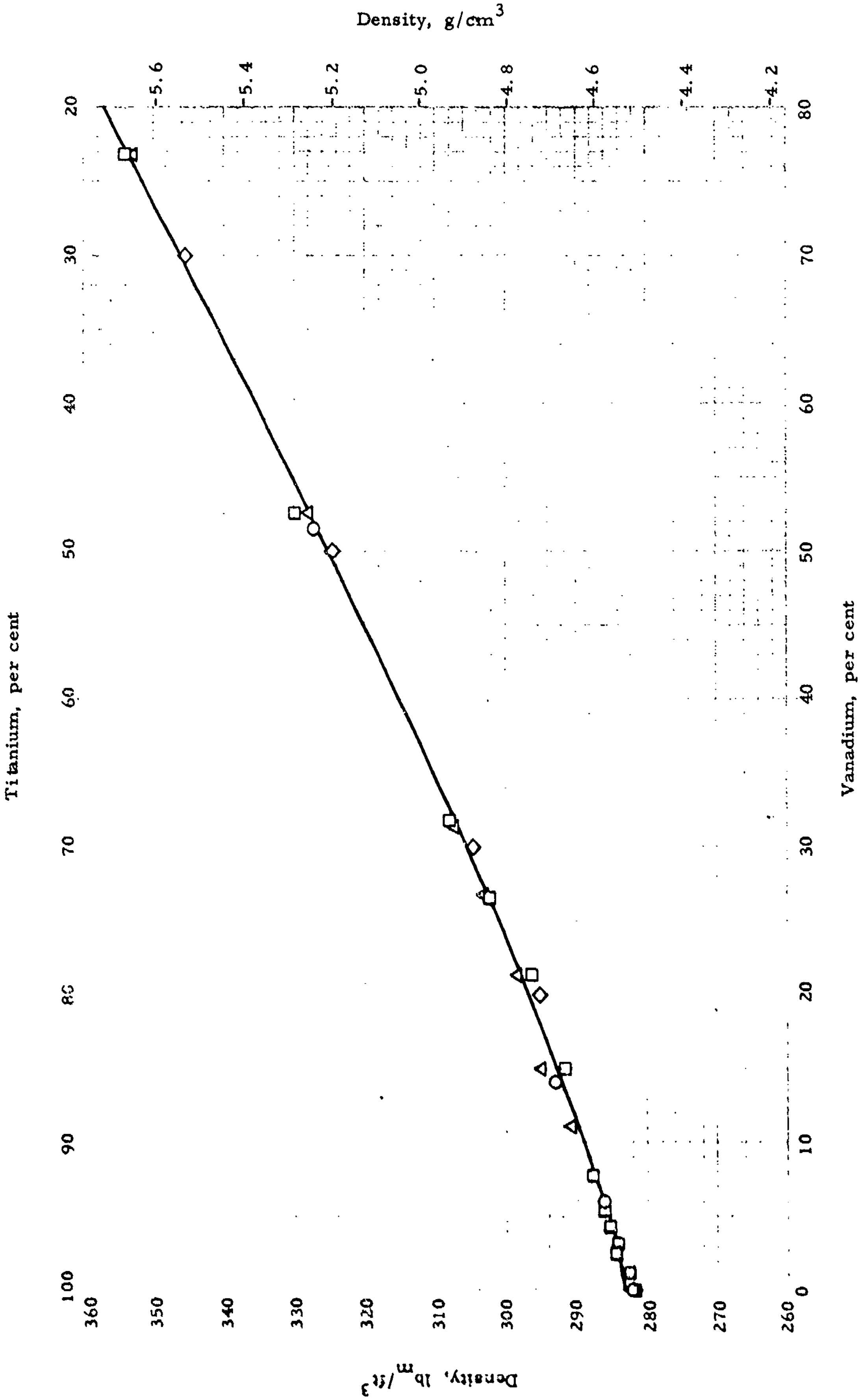


ELECTRIC RESISTIVITY -- TITANIUM + MANGANESE + X

ELECTRIC RESISTIVITY -- TITANIUM + MANGANESE + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Tyler, W. W., Nesbitt, L. B. and Wilson Jr., A. C.	53-38 also 52-55	36-540	Ti Alloy RC-130 B; 4.7% Mn; 3.99% Al; 0.14% C	Not given	Auth. est. accuracy ± 2%
□	Deem, H. W., Wood, W. D. and Lucks, C. F.	58-21	560-1460	Ti alloy C-130 AM (formerly RC-130 B). Nominal: 4% Mn; 4% Al	Potential drop	Auth. est. accuracy ± 1%
△	Ibid.	58-21	560-1460	Ti alloy C-110M (formerly RC-130 A). Nominal. 8% Mn	Same as above	Same as above



DENSITY -- TITANIUM + VANADIUM

DENSITY -- TITANIUM + VANADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R.M. and Wilhelm, H.A.	52-17	Room	0 - 52% V; 0.4% impurities	Weight in air and in water	
□	Ibid	52-17	Room	0 -76% V, 1.8% impurities	Same as above	Hot rolled
△	Ibid	52-17	Room	11 -76% V; 1.8% impurities	Same as above	Arc melted
◇	Ibid	52-17	Room	20 -70% V	Computed from x-ray measurements of lattice	

PROPERTIES OF TITANIUM + VANADIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	308 lb_m/ft^3	4.94 g/cm^3
Melting Point	3420°R *	1900°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	308	4.94

Melting Point:	°R	°K

Heat of Fusion:	Btu/lb_m	cal/g

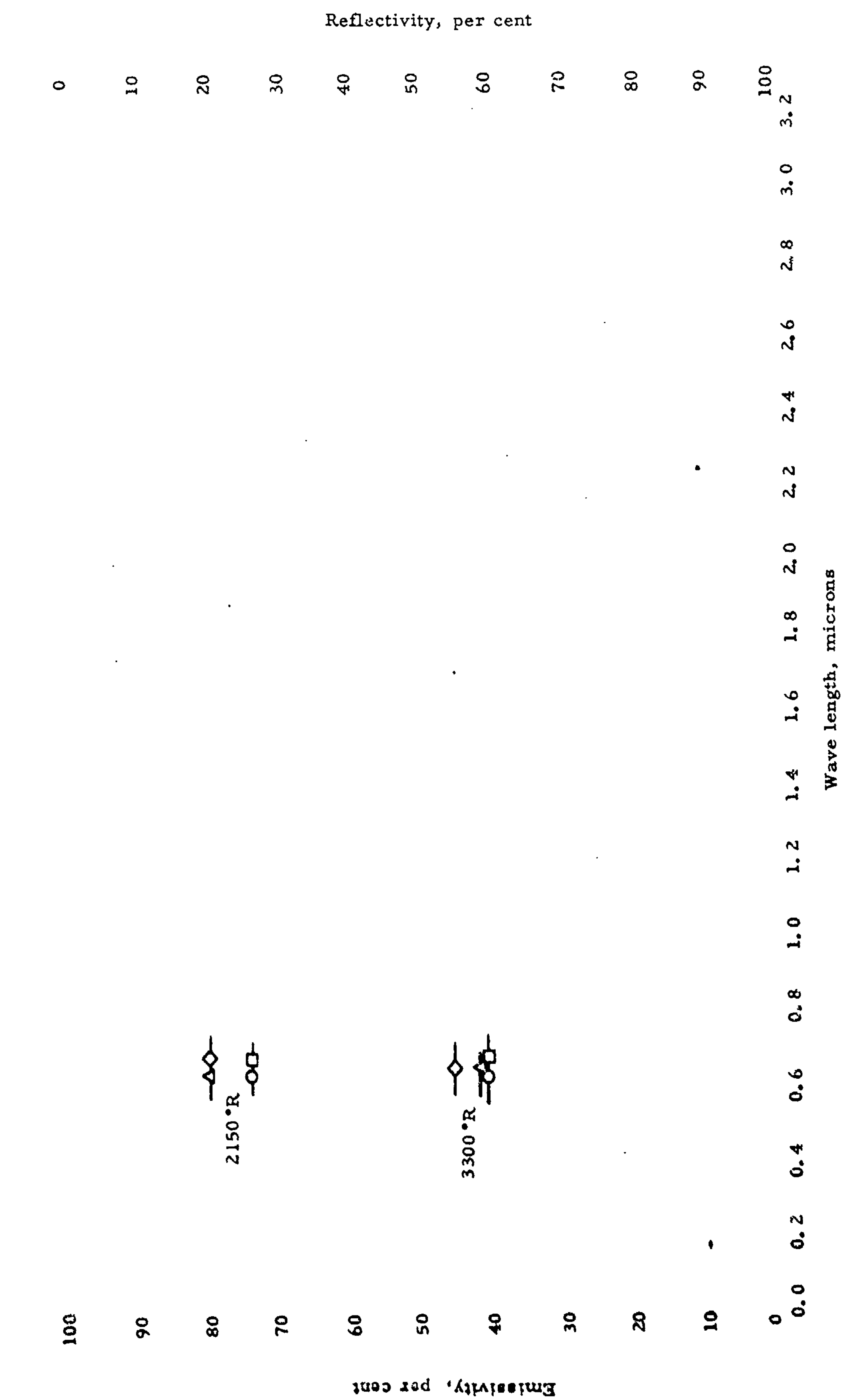
Heat of Vaporization:	Btu/lb_m	cal/g

Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF TITANIUM + VANADIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Brown, A. R. G., and Gates, P. M. R.	57-46	Room	56.8% Ti; 37.4% V; 5.4% Al; 0.67% C	ρ: weight in air and in water	Rolled bar; probably not rolled to max. density

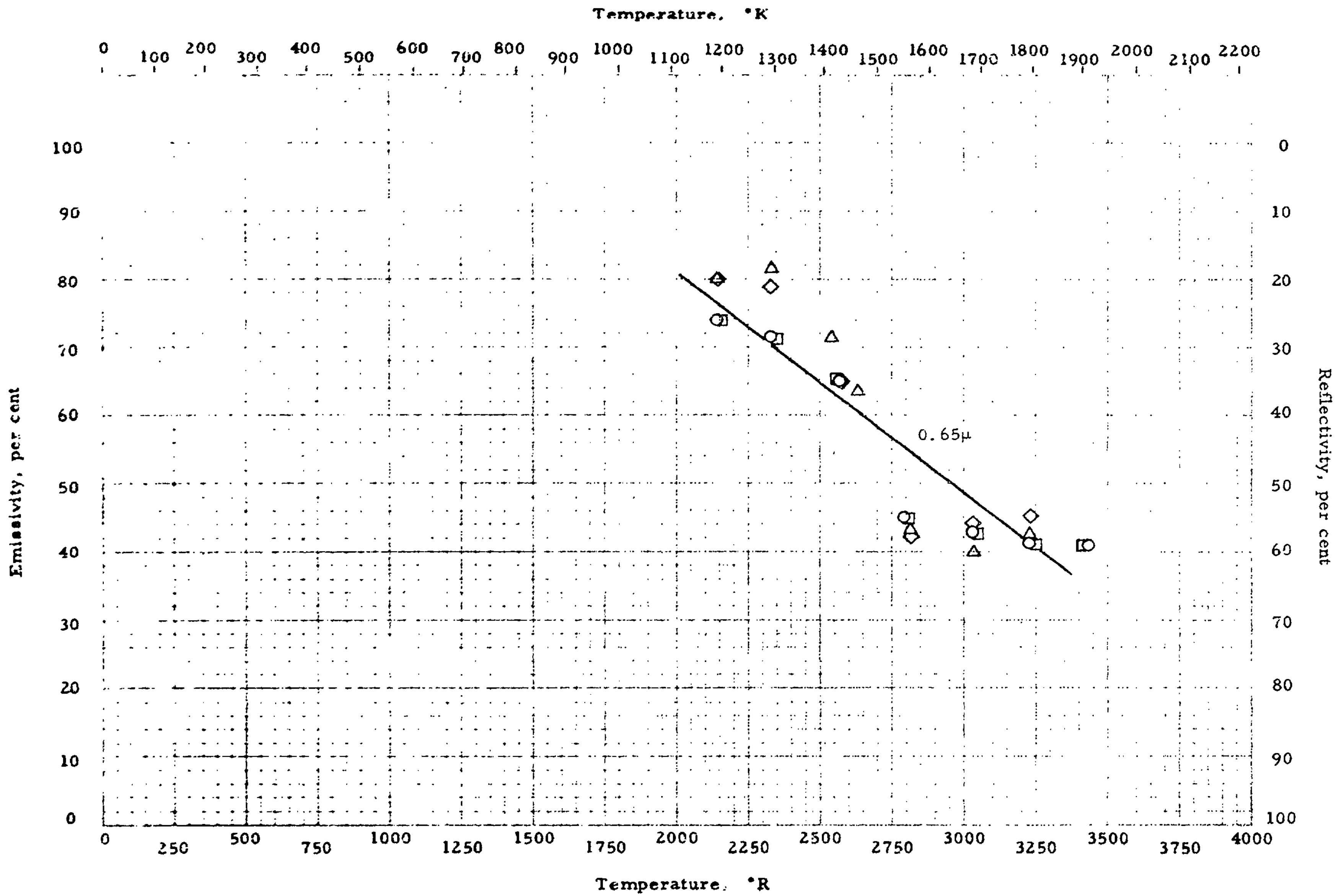


SPECTRAL EMISSIVITY -- TITANIUM + VANADIUM

SPECTRAL EMISSIVITY -- TITANIUM + VANADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R. M. and Wilhelm, H. A.	52-17	2148-3440	92.45% Ti; 7.55% V	Spectral emissivity at 0.65μ: comparative: surface brightness compared with that of a black body hole with disappearing filament optical pyrometer	Meas. in vac. of 0.1μ Hg.
□	Ibid.	52-17	2148-3440	85.23% Ti; 14.77% V	Same as above	Same as above
△	Ibid.	52-17	2148-3228	80% Ti; 20% V	Same as above	Same as above
◇	Ibid.	52-17	2148-3210	74% Ti; 26% V	Same as above	Same as above

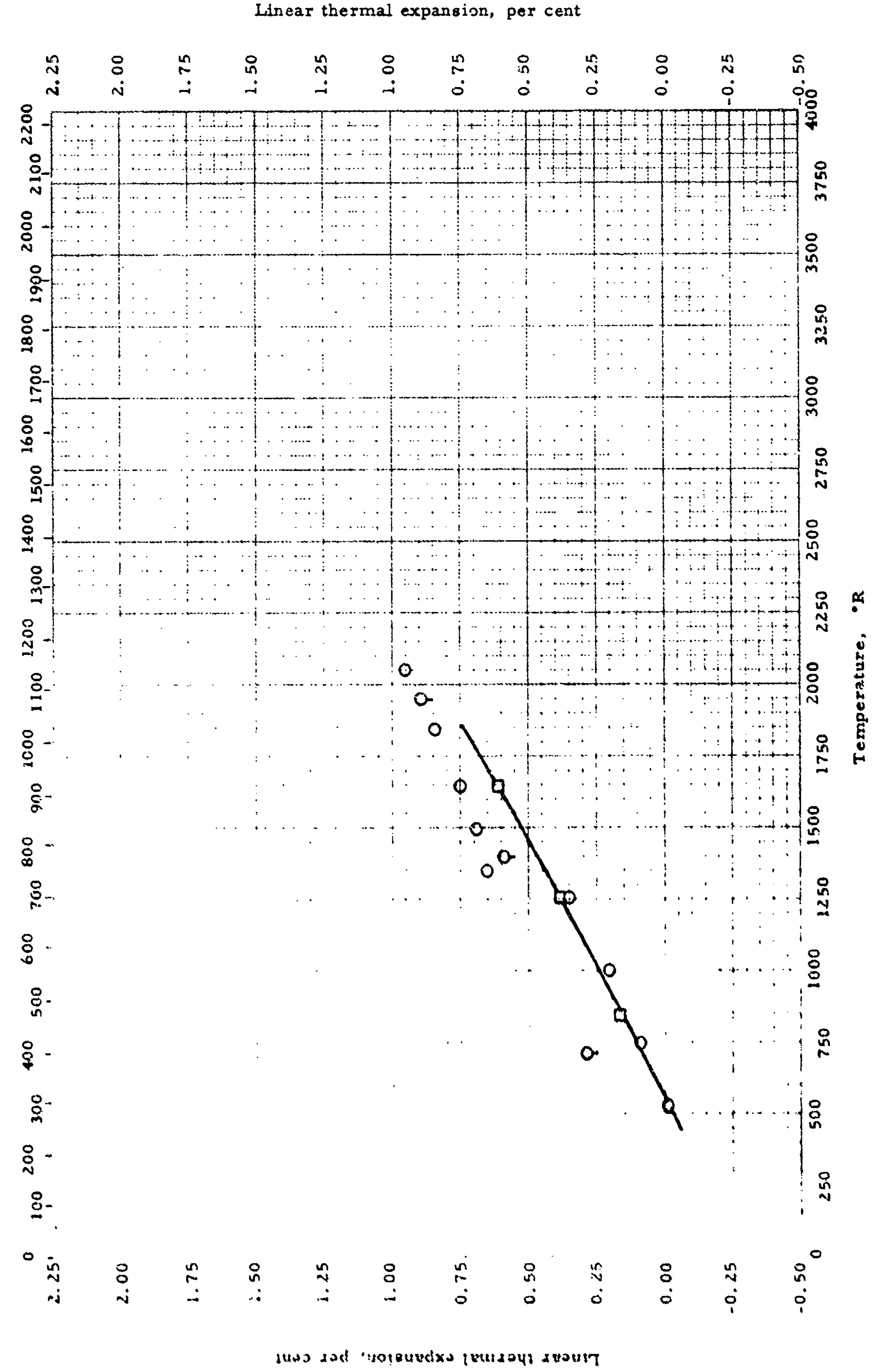


EMISSIVITY -- TITANIUM + VANADIUM

EMISSIVITY -- TITANIUM + VANADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powers, R. M. and Wilhelm, H. A.	52-17	2148-3440	92.45% Ti; 7.55% V	Spectral emissivity at 0.65μ: comparative: surface brightness compared with that of a black body hole with a disappearing filament optical pyrometer	Meas. in vac. of 0.1μ Hg
□	Ibid.	52-17	2148-3440	85.23% Ti; 14.77% V	Same as above	Same as above
△	Ibid.	52-17	2148-3228	80% Ti; 20% V	Same as above	Same as above
◇	Ibid.	52-17	2148-3210	74% Ti; 26% V	Same as above	Same as above

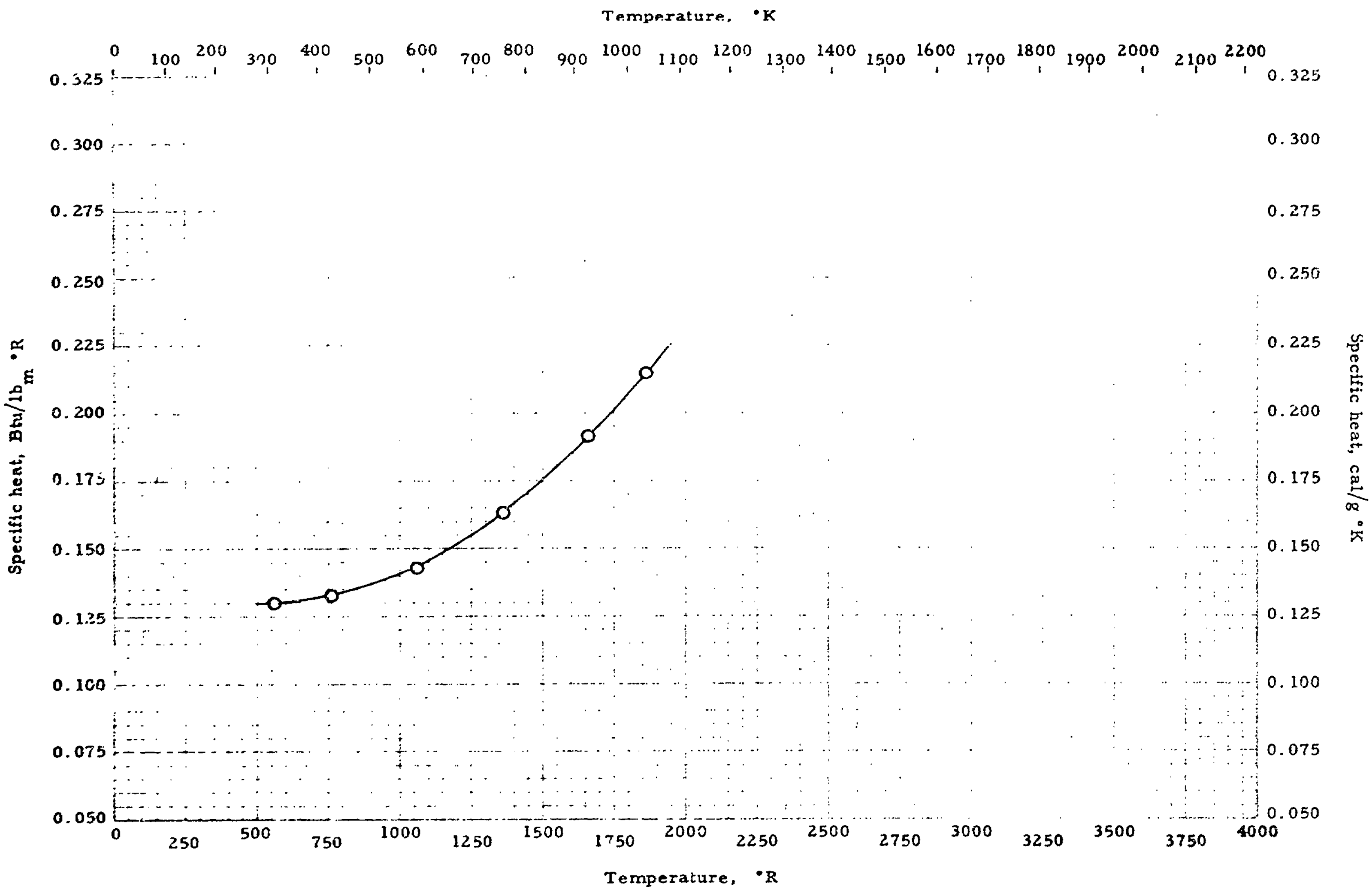


LINEAR THERMAL EXPANSION -- TITANIUM + VANADIUM

LINEAR THERMAL EXPANSION -- TITANIUM + VANADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref	Range, °R	Material Composition	Test Method	Remarks
○	Adenstedt, H. K., Pequignot, J. R. and Raymer, J. M.	52-118	528-2050	15%V; prepared from 99.8%V and 99.9 + % Ti	Leitz-Bollenrath quartz tube dilatometer in vacuum	Cold rolled; 21 hr. at 1450°F; water quenched
□	Ibid.	52-118	528-2050	10-50%V alloys prepared from 99.8% pure V and 99.9 + % pure Ti	Same as above	Cast; cold rolled; vac. annealed. Average of 5 samples with 10, 20, 30, 40, and 50 wt%V respectively; max. dev. ± 1%

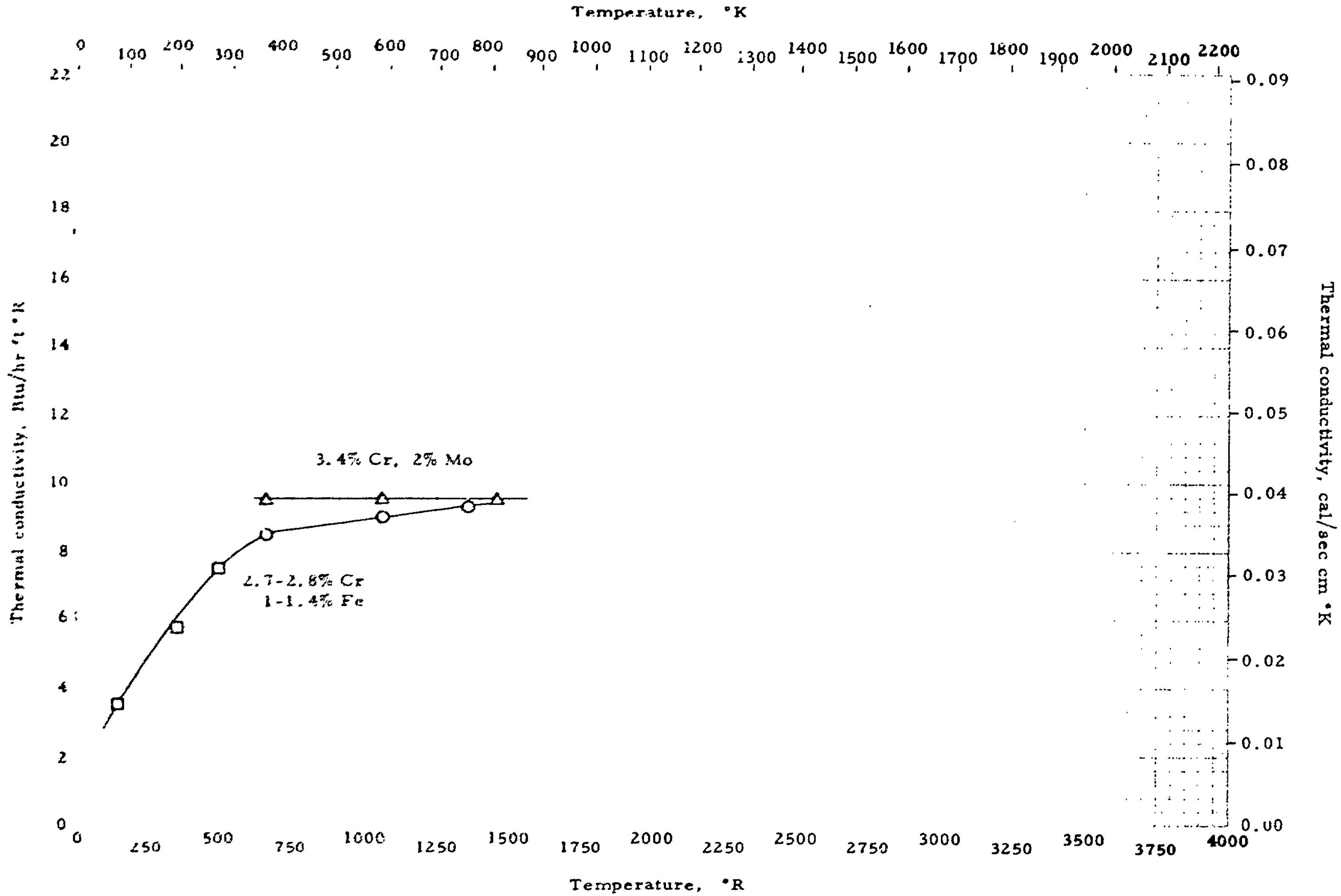


SPECIFIC HEAT -- TITANIUM + CHROMIUM + X

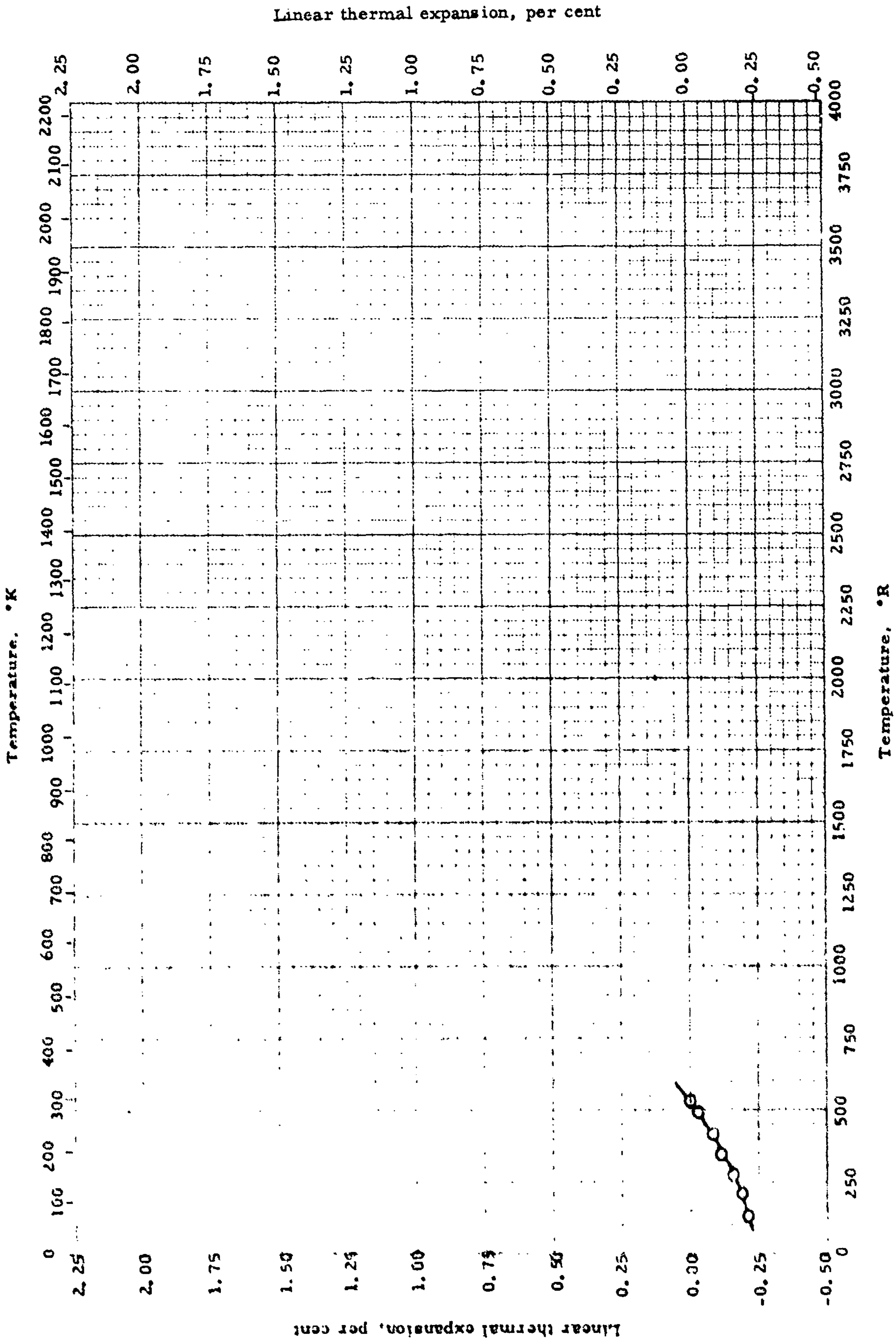
SPECIFIC HEAT -- TITANIUM + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Loewen, E. G.	56-21	560-1860	95.65% Ti; 2.71% Cr; 1.40% Fe; 0.105% O; 0.076% N; 0.05% C; 0.0092% H	Drop method; copper calorimeter	



THERMAL CONDUCTIVITY -- TITANIUM + CHROMIUM + X

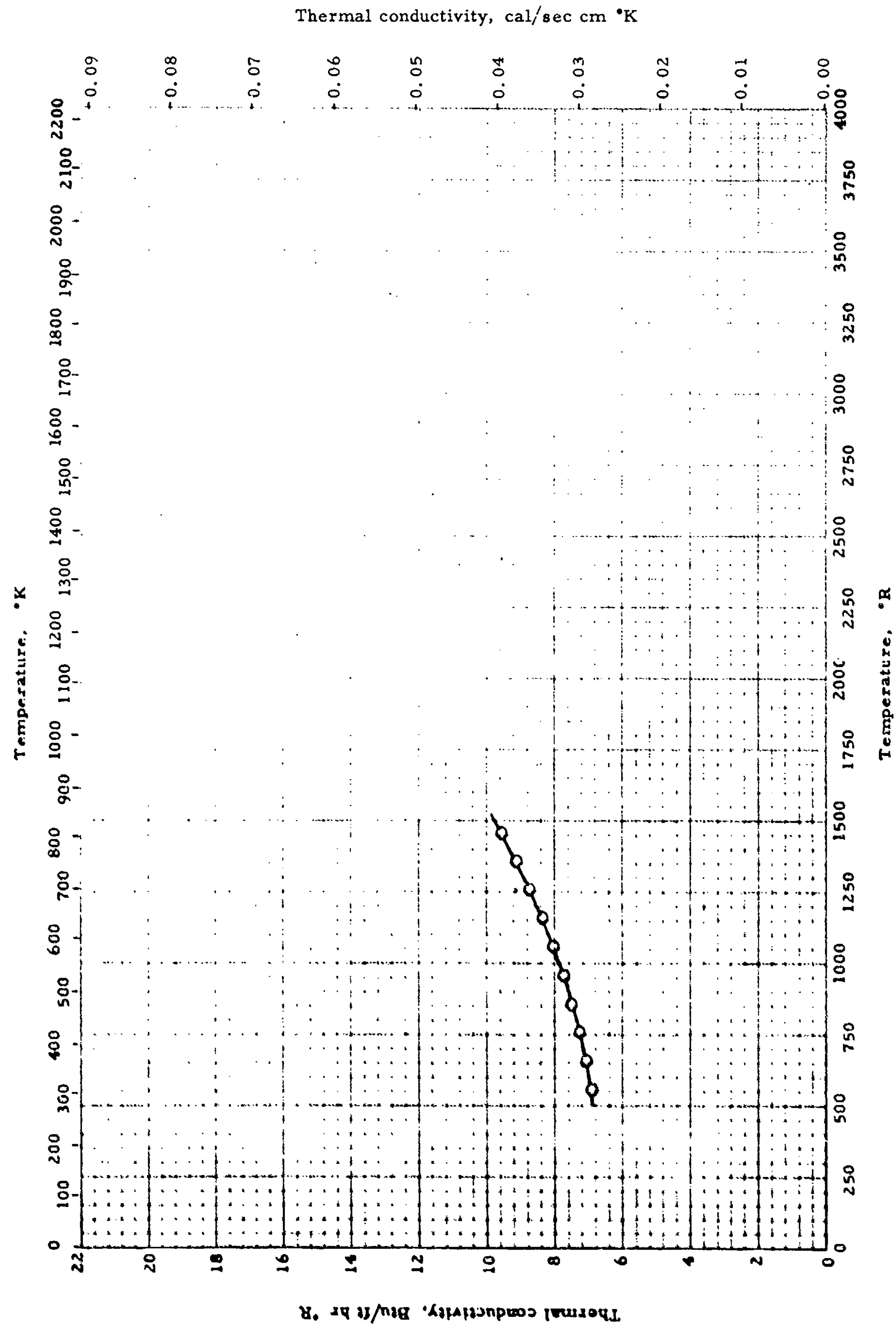


LINEAR THERMAL EXPANSION -- TITANIUM + CHROMIUM + X

LINEAR THERMAL EXPANSION -- TITANIUM + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Bishop, S.M., Spretnak, J.W. and Fontana, M.G.	52-122	132-528	Ti Alloy RC-130B, 95.8% Ti (by diff.); 2.7% Cr; 1.3% Fe; 0.08% N max; 0.05% C max	Quartz dilatometer with dial gauge. Temp. by thermocouple	Annealed 1 hr. at 1300°F

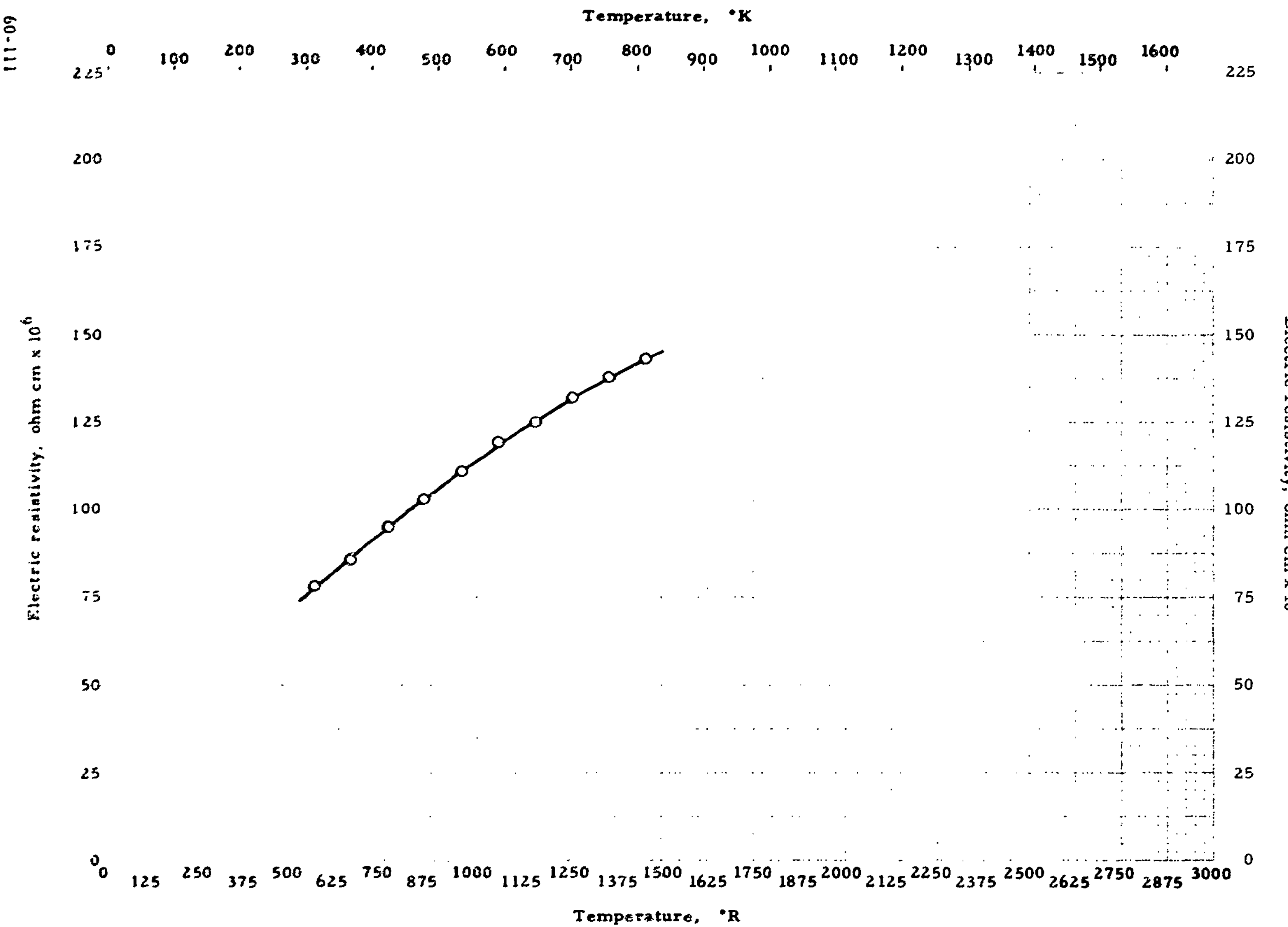


THERMAL CONDUCTIVITY -- TITANIUM + IRON + CHROMIUM + X

THERMAL CONDUCTIVITY -- TITANIUM + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Deem, H. W., Wood, W. D. and Lucks, C. F.	58-21	560-1460	Ti-140A, Nominal: 2.2% Fe; 2.1% Cr; 2.0% Mo	Comparative, rods	Armco Iron Standard. Auth. est. accuracy ± 5%

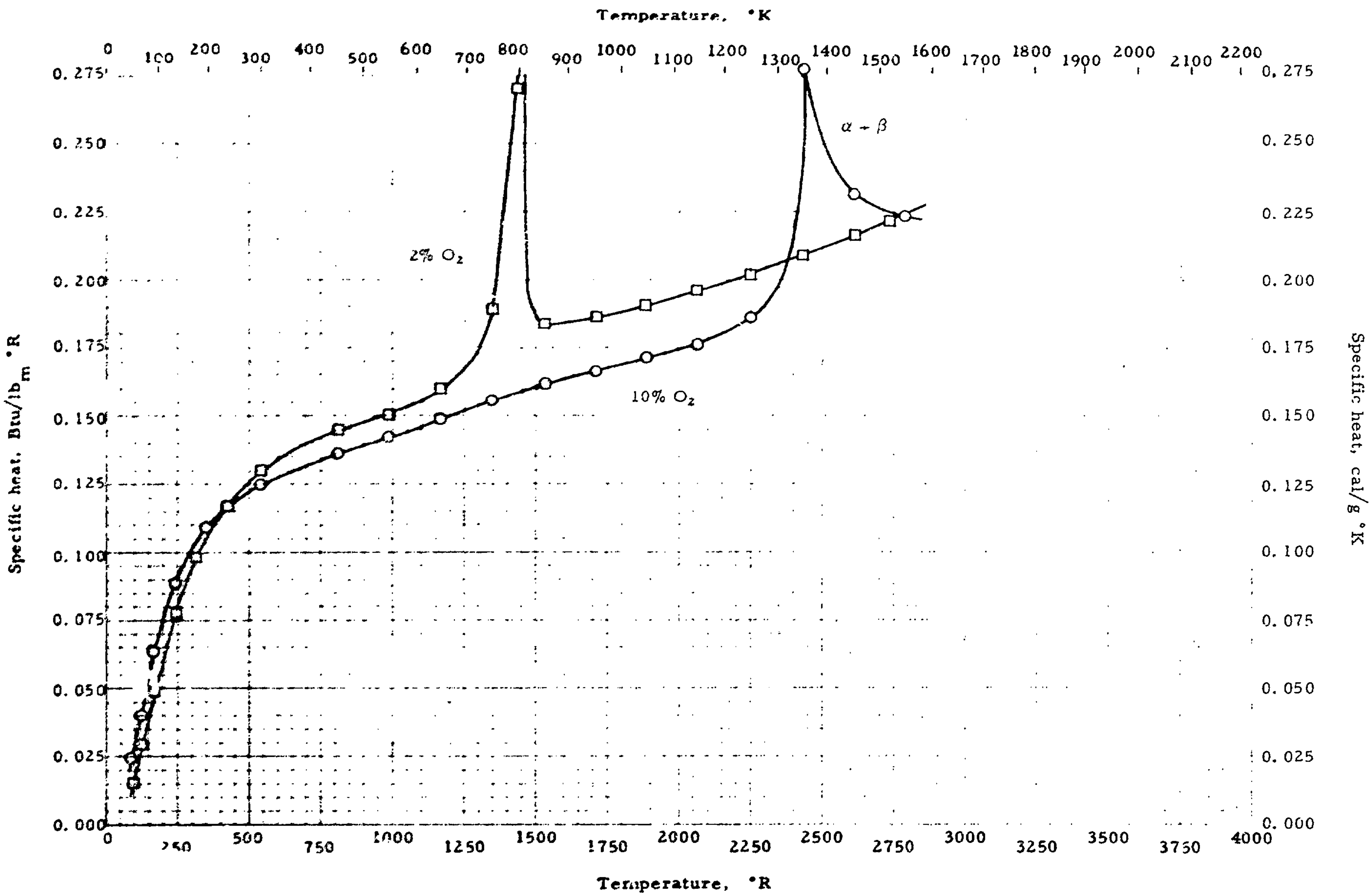


ELECTRIC RESISTIVITY -- TITANIUM + IRON + CHROMIUM + X

ELECTRIC RESISTIVITY -- TITANIUM + IRON + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Deem, H. W., Wood, W. D. and Lucks, C. F.	58-2?	560-1460	Ti-140A. Nominal: 2.2% Fe; 2.1% Cr; 2.0% Mo	Potential drop	Auth. est. accuracy ± 1%

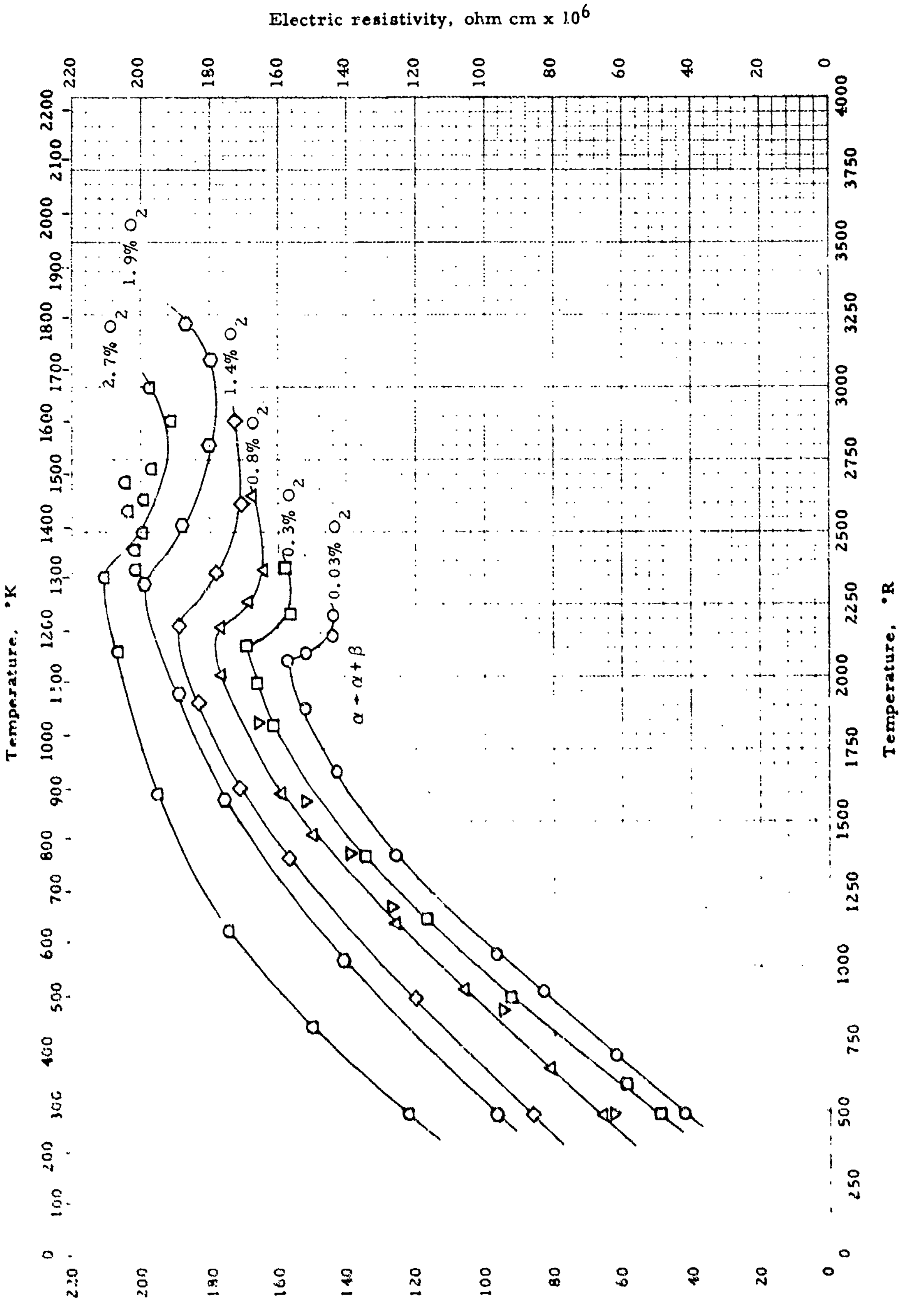


SPECIFIC HEAT -- TITANIUM + OXYGEN

SPECIFIC HEAT -- TITANIUM + OXYGEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mah, A. D., Kelley, K. K. et al.	57-55	90-2790	2.02% O_2; prepared from "extremely high purity" Ti	Below 298.15°K: guarded sample Above 298.15°K: drop method, Cu block calorimeter	$TiO_{0.062}$ Above 298.15°K: plotted points derived from auth. smoothed enthalpy vs. temp. data as $c_p = \Delta h/\Delta t$
□	Ibid.	57-55	90-2790	10.04% O_2, raw material same as above	Same as above	$TiO_{0.334}$. Same as above

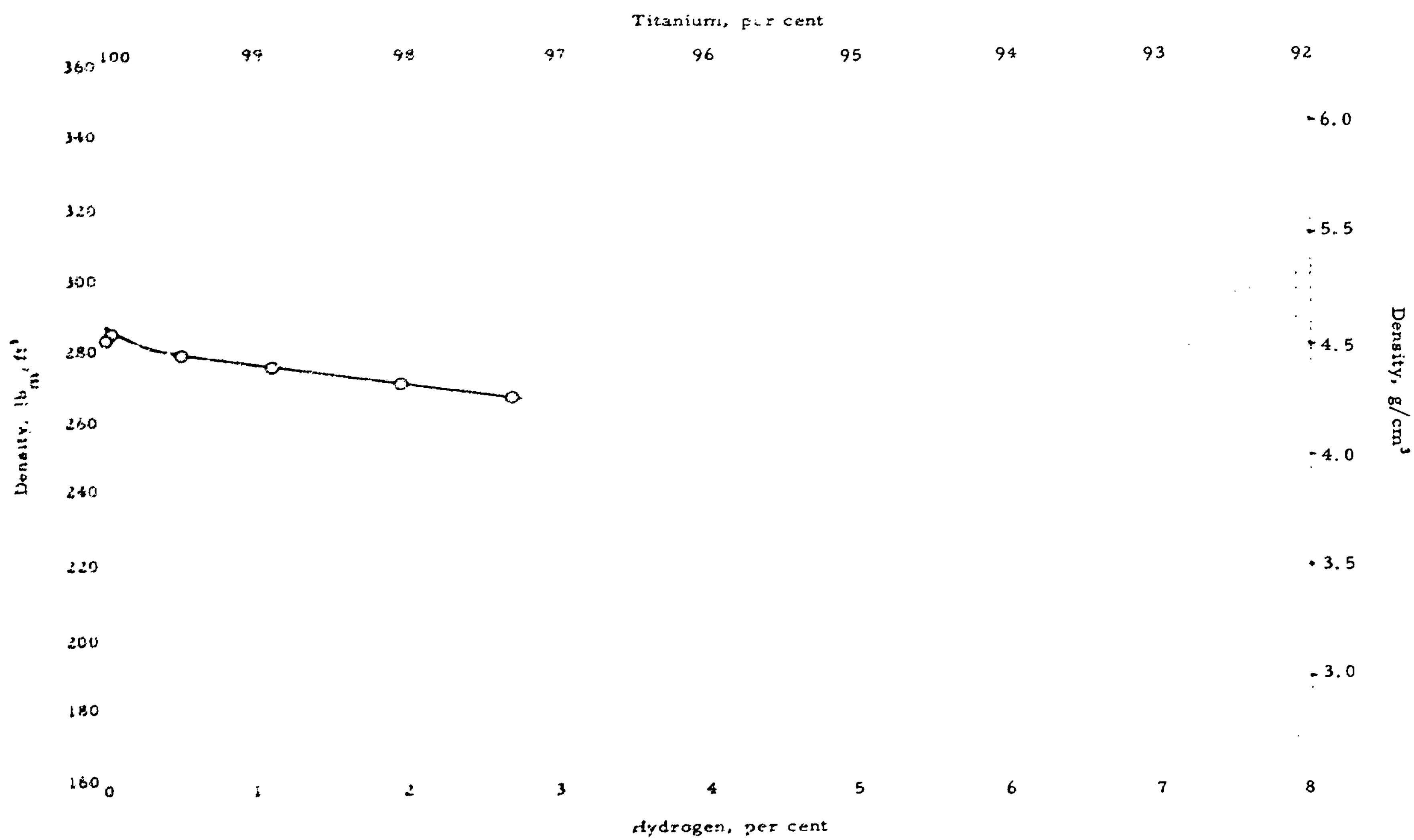


ELECTRIC RESISTIVITY -- TITANIUM + OXYGEN + X

ELECTRIC RESISTIVITY -- TITANIUM + OXYGEN + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	DePue, L. A., and Chapin, E. J.	56-9	492-2216	0.028% O_2; 0.002% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Potential drop	High purity iodide titanium and pure TiO_2 fused in He atmos. and remelted several times
□	Ibid.	56-9	492-2382	0.288% O_2; 0.001% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Same as above	Same as above
△	Ibid.	56-9	492-2608	0.848% O_2; 0.002% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Same as above	Same as above
◇	Ibid.	56-9	492-2891	1.40% O_2; 0.002% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Same as above	Same as above
▽	Ames, S. L., and McQuillan, A. D.	[illegible]	492-[illegible]	1.45% O_2	Double balance bridge	Prepared from iodide refined (α-phase) titanium and spectroscopically pure TiO_2
○	DePue, L. A., and Chapin, E. J.	[illegible]	492-[illegible]	1.40% O_2; 0.003% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Potential drop	High purity iodide titanium and pure TiO_2 fused in He atmos. and remelted several times
○	Ibid.	56-9	492-2994	2.68% O_2; 0.006% N_2; Mo, Al, Si, Cu, Mg, Mn, Fe, Sn also present as impurities	Same as above	Same as above

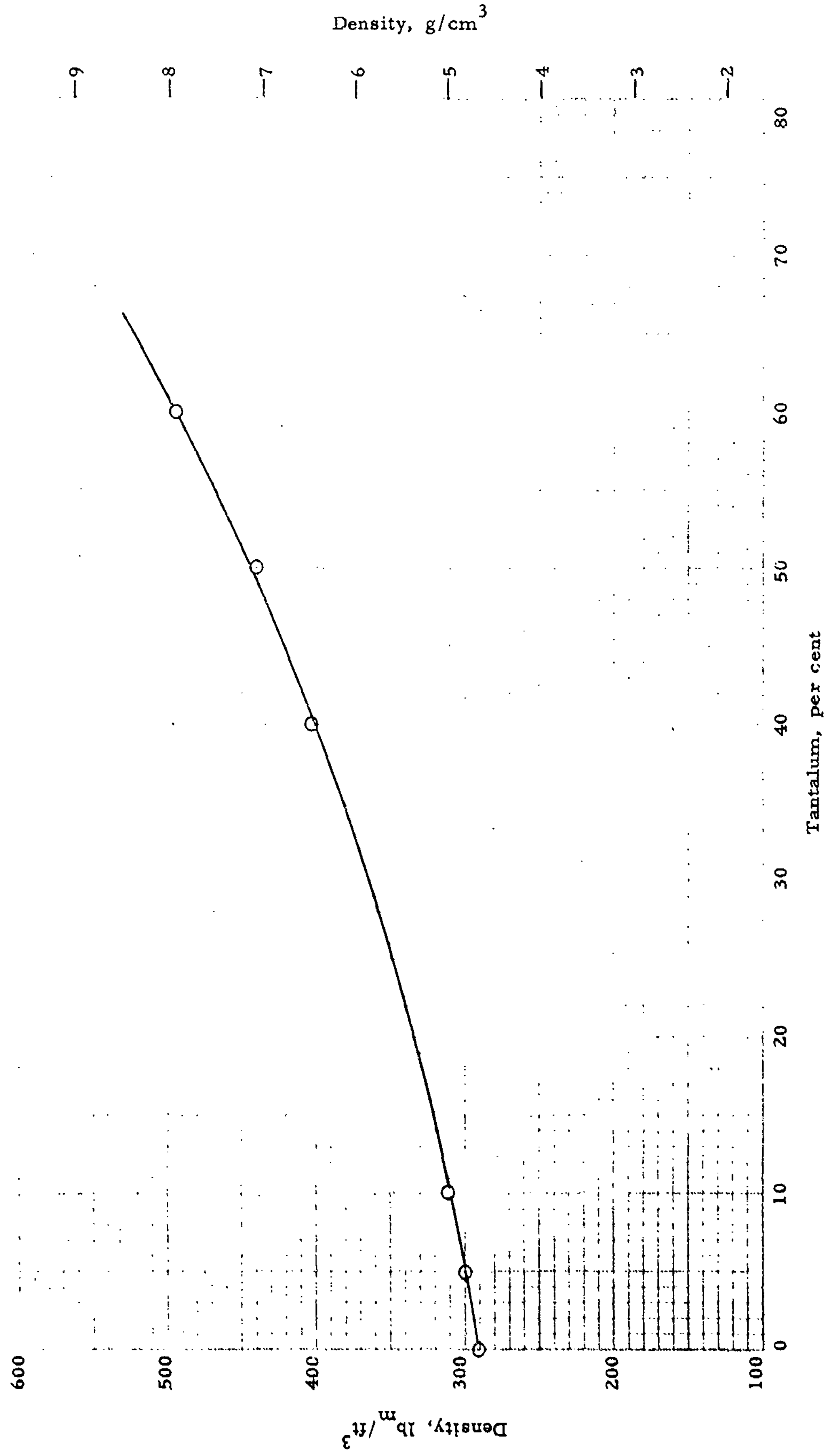


DENSITY -- TITANIUM + HYDROGEN

DENSITY -- TITANIUM + HYDROGEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Lenning, G.A., Craighead, C.M. and Jaffee, R.I.	52-13	Room	0-2.7% H; 99.92% pure; 0.013% Al; 0.01% Mn; 0.004% N; 0.0035% Fe; 0.0025% Ni; 0.001% ea. Mo, Sn, Mg; 0.0072 ± 0.0007% H_2 before alloying; O_2 not determined.	Weight in air and in water	Titanium prepared from arc melted titanium iodide, or purchased pure Ti

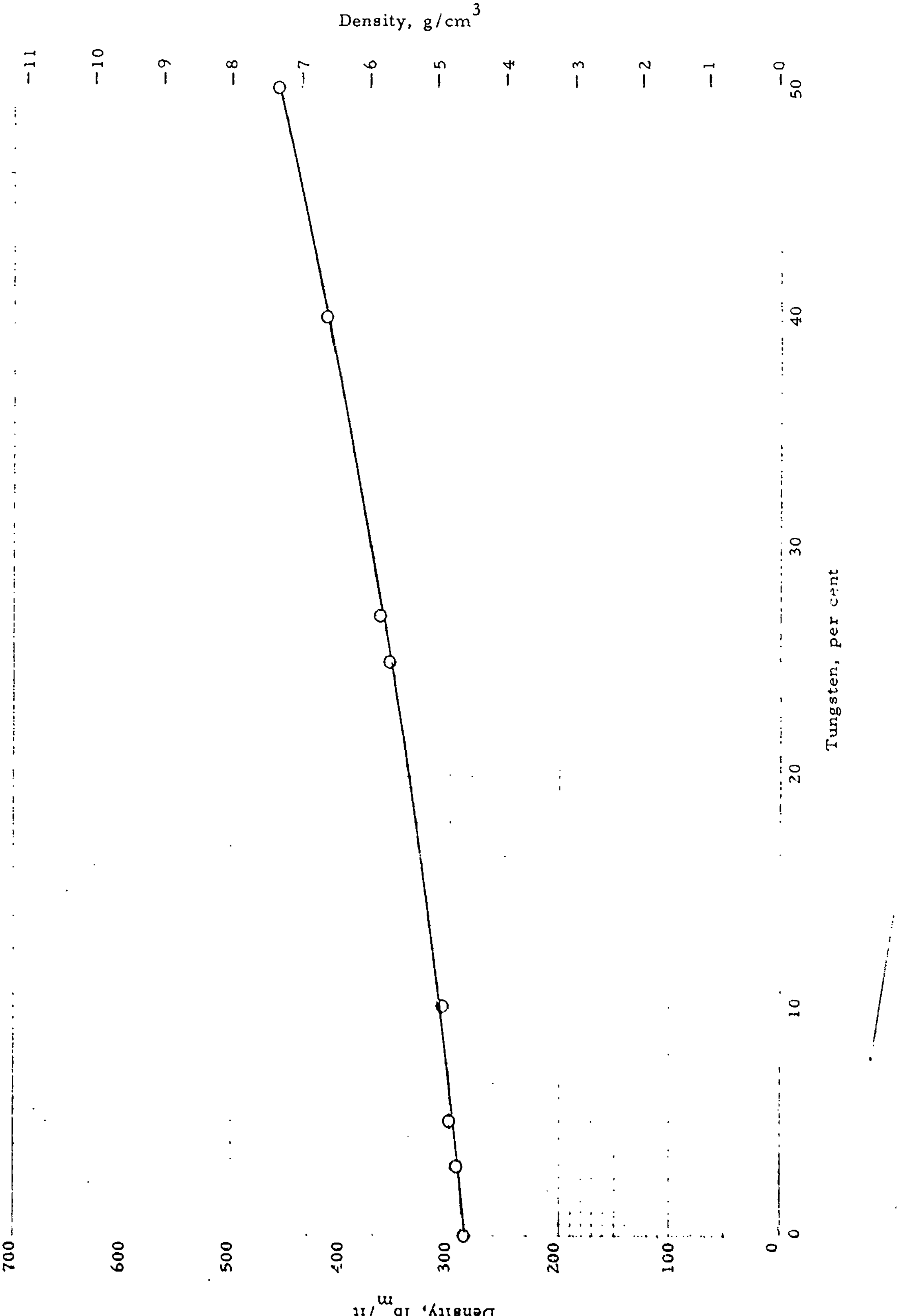


DENSITY -- TITANIUM + TANTALUM

DENSITY - TITANIUM + TANTALUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Maykuth, D. J., Ogden, H. R. et al.	54-57	Room	Alloy series: 0 - 60% Ta	ρ: weight in air and in water	

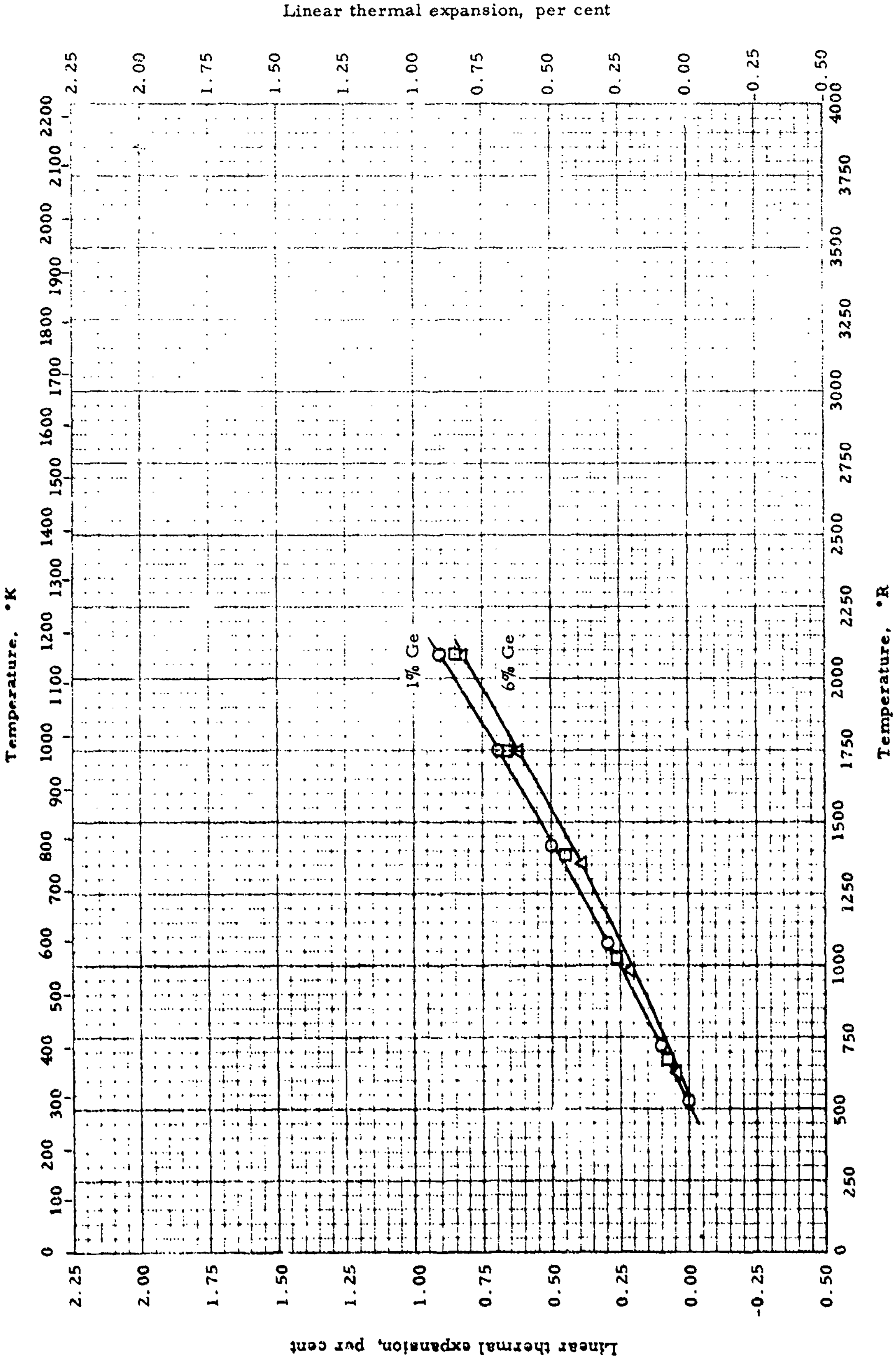


DENSITY -- TITANIUM + TUNGSTEN

DENSITY -- TITANIUM + TUNGSTEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Maykuth, D.J., Ogden, H.R. et al.	54-57	Room	Alloy series: 0 - 5% W	ρ: weight in air and in water	

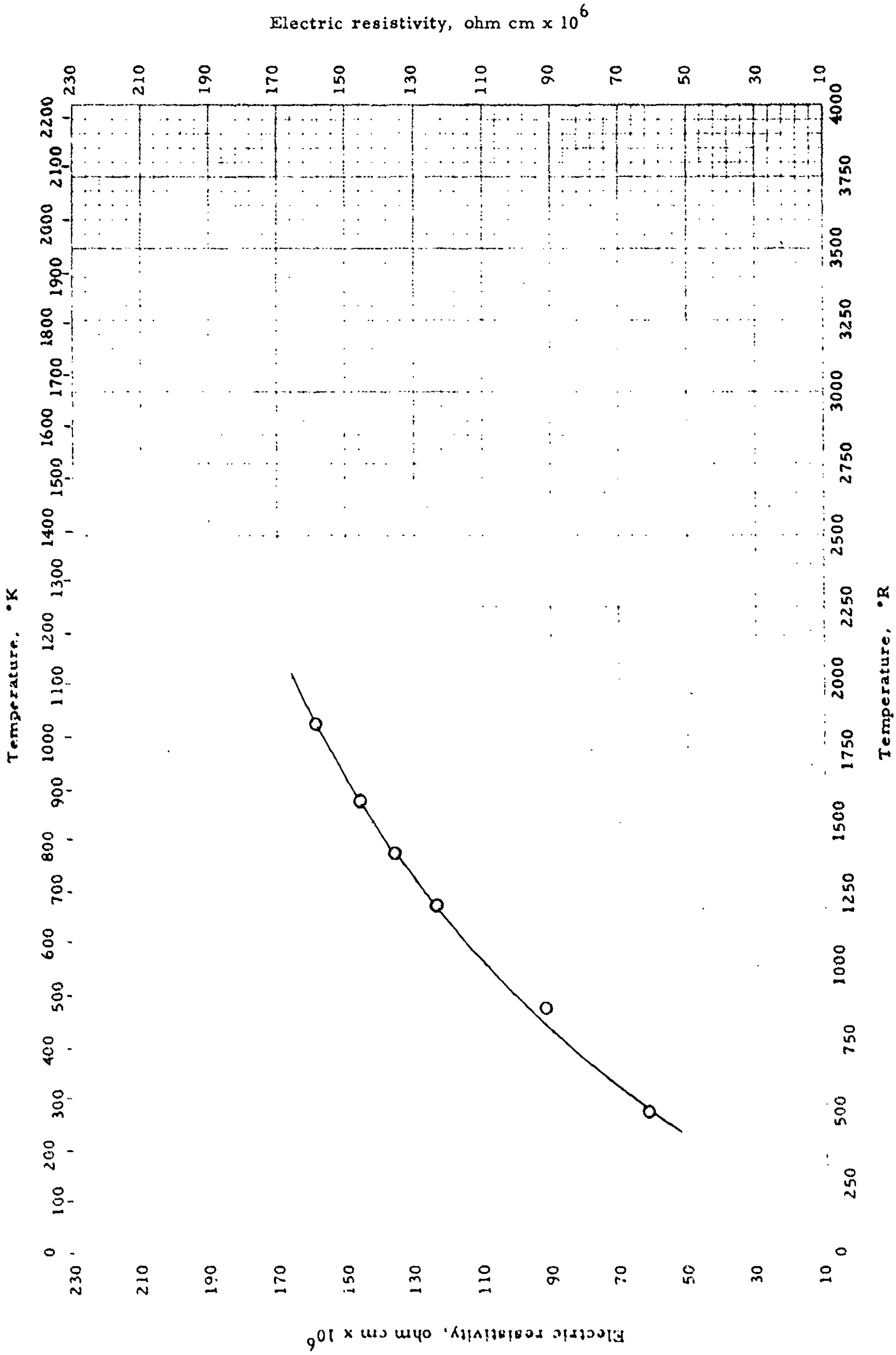


LINEAR THERMAL EXPANSION -- TITANIUM + GERMANIUM

LINEAR THERMAL EXPANSION -- TITANIUM + GERMANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Peterson, V. C. and Huber, R. W.	55-101	528-2080	1% Ge	Quartz Dilatometer with automatic plotting from differential transformer pickup	Heating rate 50 °C/min.
□	Ibid.	53-101	528-2080	2% Ge	Same as above	Same as above
△	Ibid.	53-101	528-2080	6% Ge	Same as above	Same as above

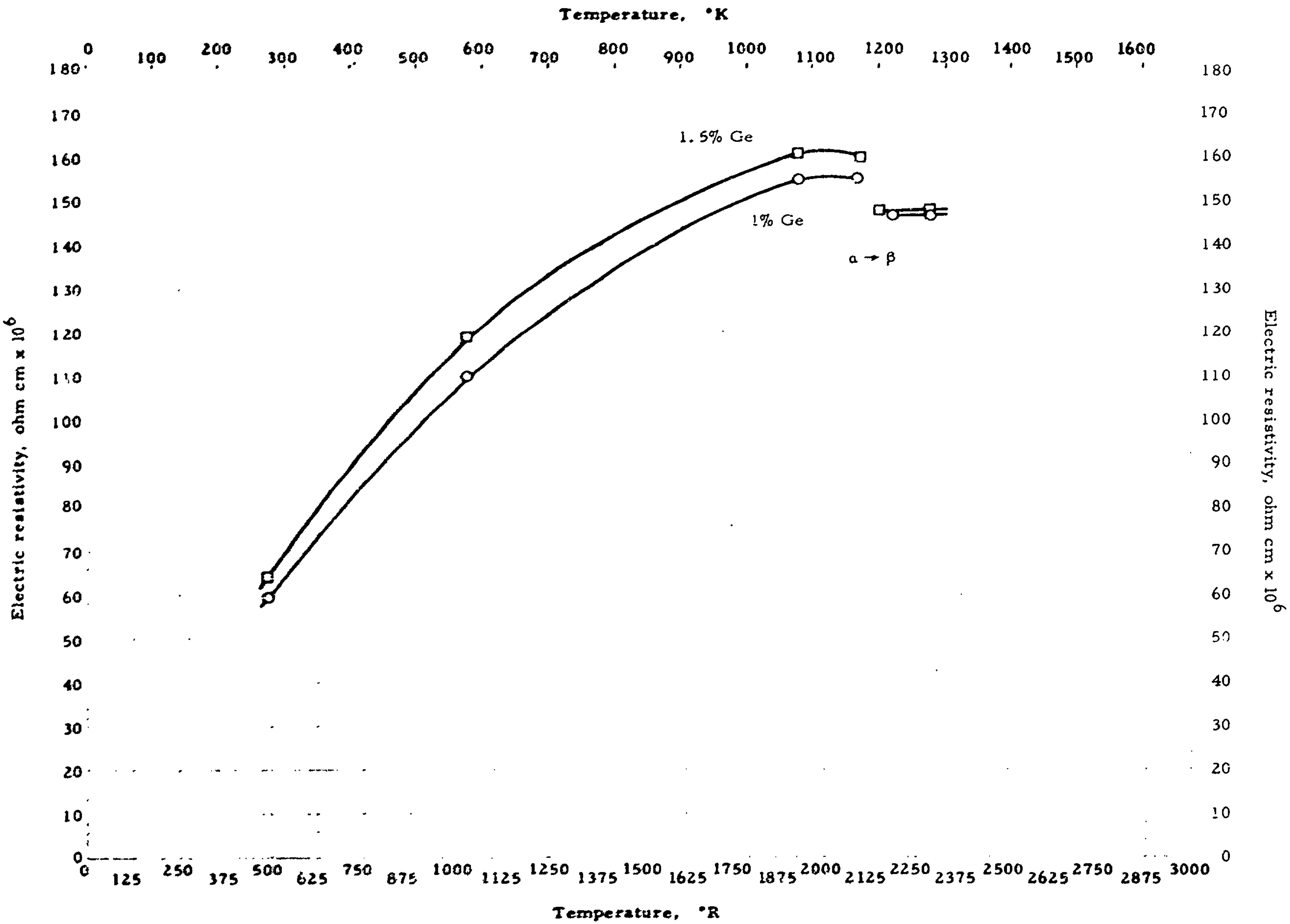


ELECTRIC RESISTIVITY -- TITANIUM + COPPER

ELECTRIC RESISTIVITY -- TITANIUM + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Ames, S. L. and McQuillan, A. D.	56-15	492-1842	Iodide Ti (α-phase); 1% Cu (99.99% pure)	Double balance bridge	High temp. work in vacuum of 10^{-6} mm Hg. Auth. est. accuracy 1%

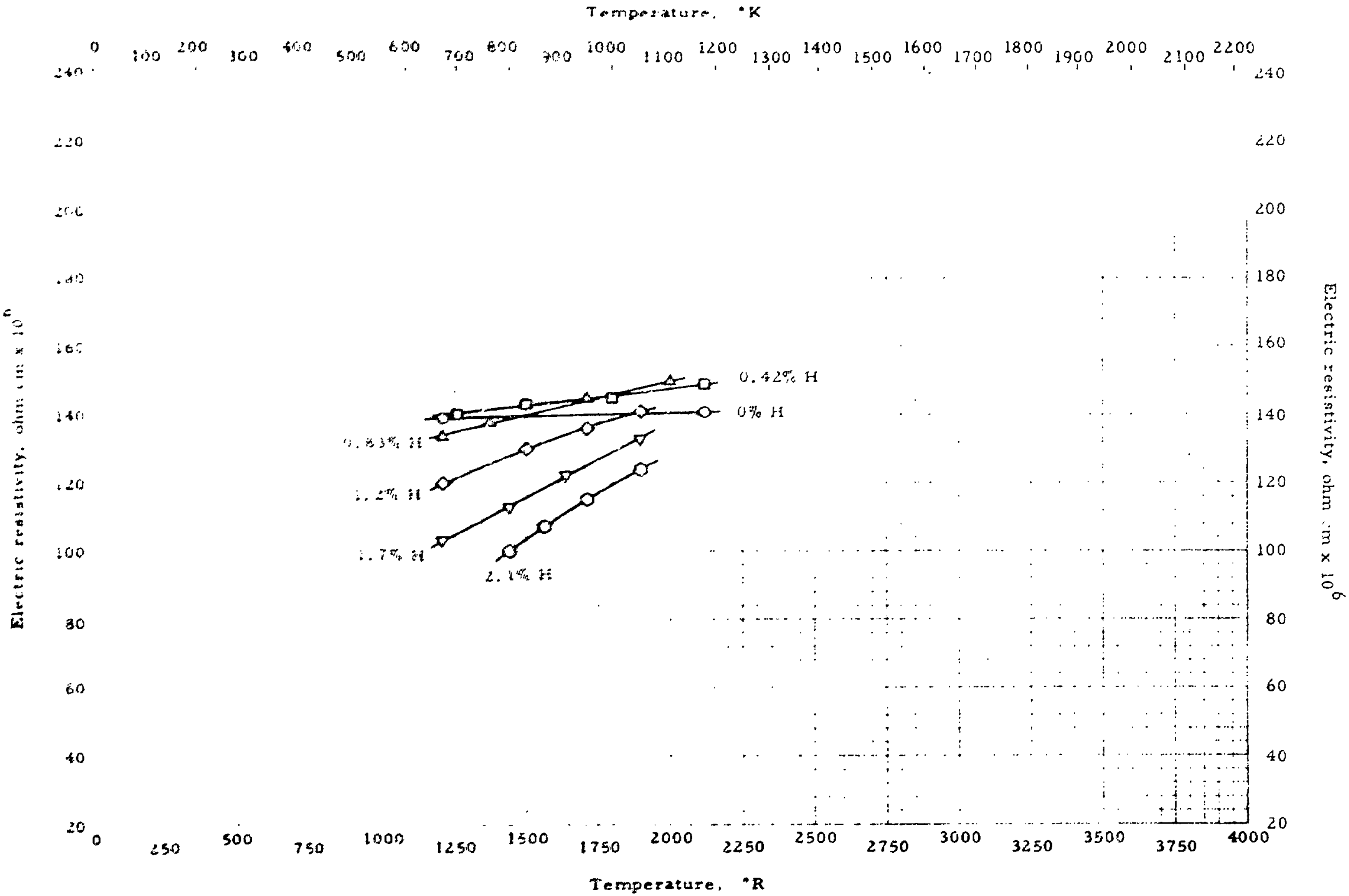


ELECTRIC RESISTIVITY -- TITANIUM + GERMANIUM

ELECTRIC RESISTIVITY -- TITANIUM + GERMANIUM

REFERENCE INFORMATION

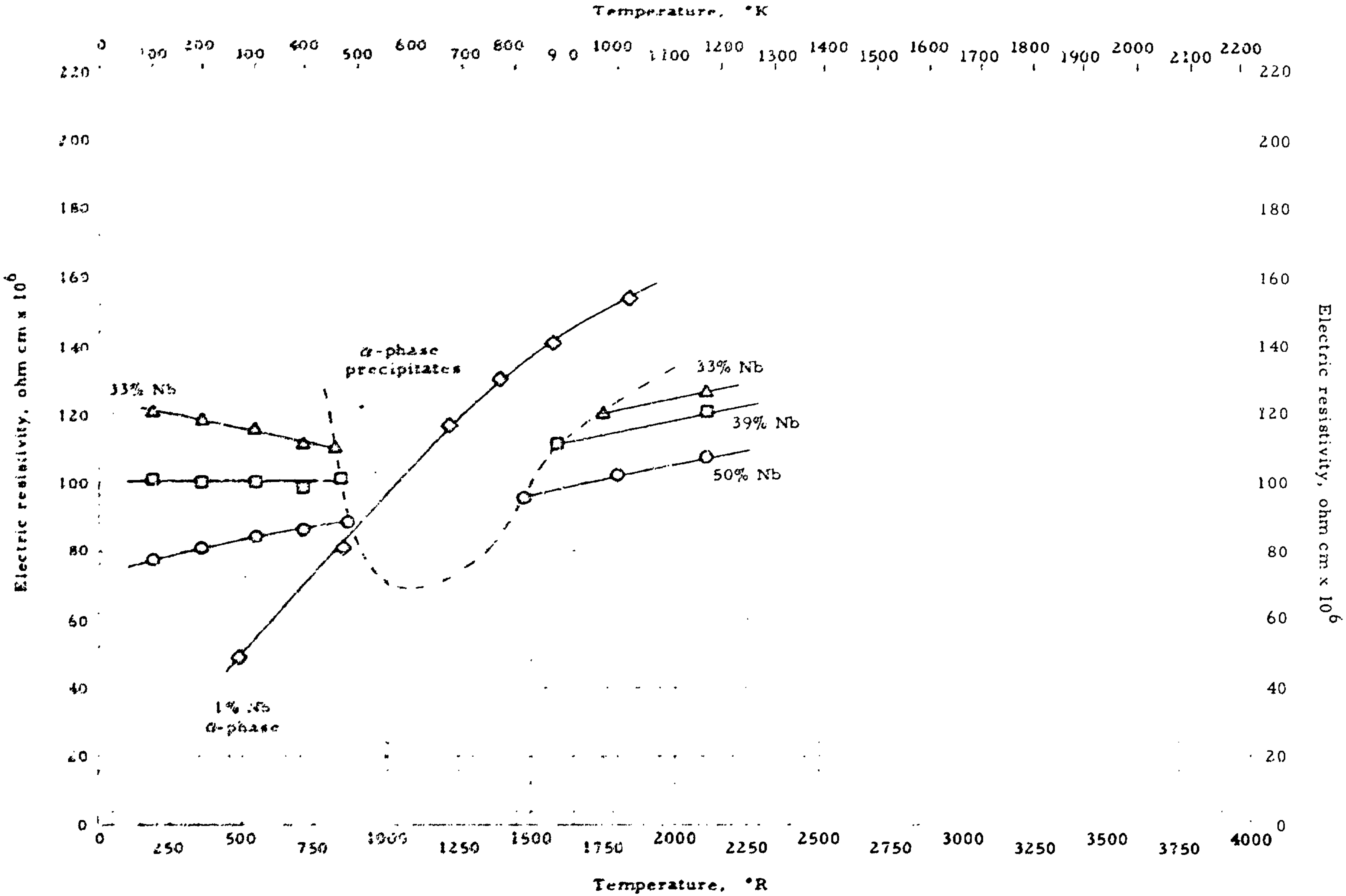
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Petersen, V. C. and Huber, R. W.	55-101	492-2292	99% Ti; 1% Ge	Potential drop	Heating rate 50 °C/min.
□	Ibid.	55-101	492-2292	98.5% Ti; 1.5% Ge	Same as above	Same as above



ELECTRIC RESISTIVITY -- TITANIUM + HYDROGEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S.L. and McQuillan, A.D.	56-95	1212-2119	0% H	Double bridge	Rod of iodide-titanium in equilibrium with H_2 atm.
□	Ibid.	56-95	1212-2119	0.42% H	Same as above	Same as above
△	Ibid.	56-95	1212-2000	0.83% H	Same as above	Same as above
◇	Ibid.	56-95	1212-1896	1.2% H	Same as above	Same as above
▽	Ibid.	56-95	1212-1896	1.7% H	Same as above	Same as above
◌	Ibid.	56-95	1212-1896	2.1% H	Same as above	Same as above

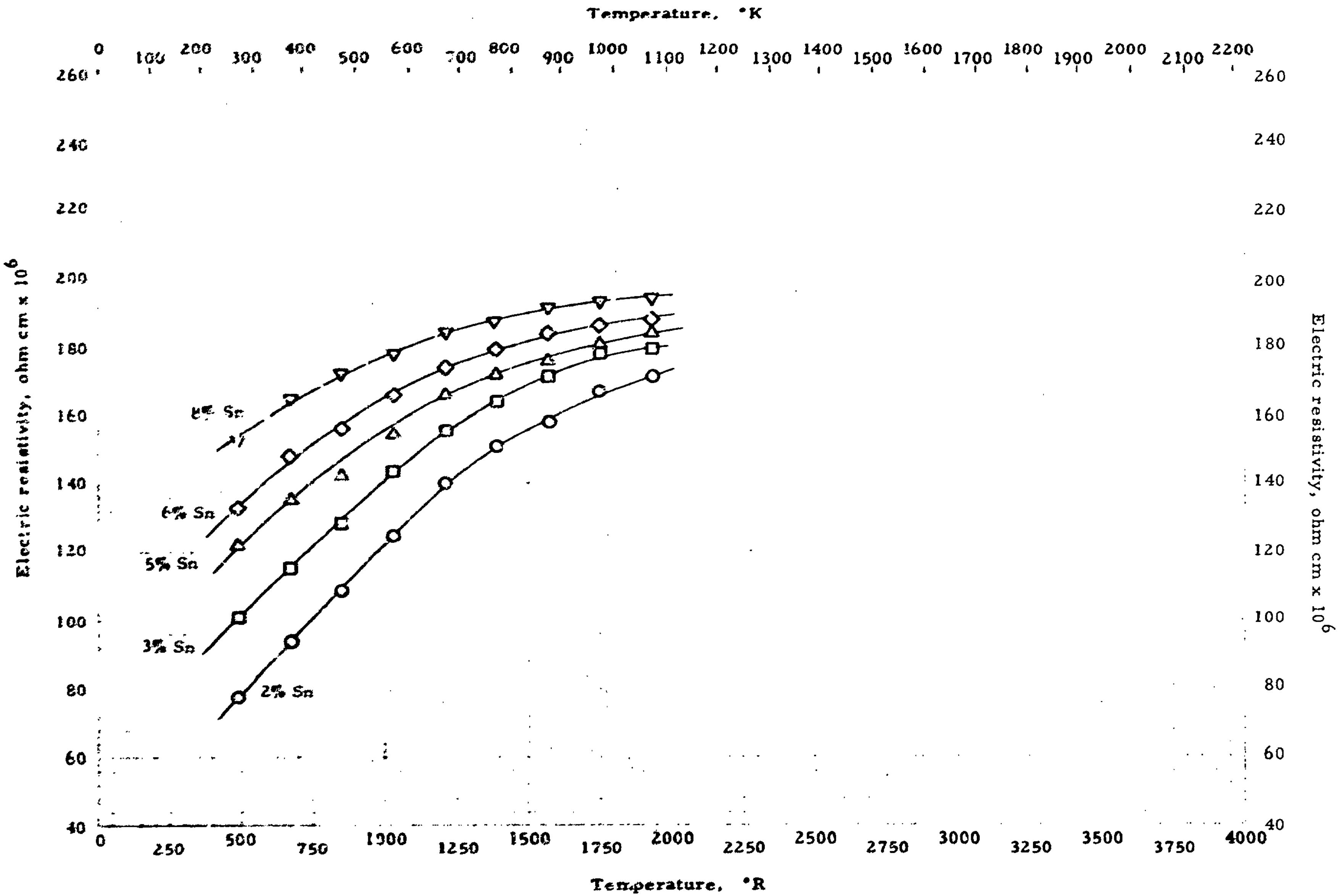


ELECTRIC RESISTIVITY -- TITANIUM + NIOBIUM

ELECTRIC RESISTIVITY - - TITANIUM + NIOBIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S. L. and McQuillan, A. D.	54-25	180-2112	50% Ti; 50% Nb; β-phase; prepared from spectroscopically pure Nb and iodide refined Ti (0.2 atomic% Zr)	Double bridge	Cast, rolled, remelted, hot forged, surface layers removed, cold swaged, homogenized 70 hr. at 1050°C in vacuum, quenched to retain β phase. Tested in vacuum
□	Ibid.	54-25	180-2112	60.7% Ti; 39.3% Nb; β-phase; raw materials same as above	Same as above	Same as above
△	Ibid.	54-25	180-2112	67.3% Ti; 32.7% Nb; β-phase; raw materials same as above	Same as above	Same as above
◇	Ames, S. L. and McQuillan, A. D.	55-15	492-1842	99% Ti, 1% Nb; α-phase; prepared from spectroscopically pure Nb and iodide refined Ti	Double bridge	Tested in vacuum. Auth. est. precision ± 1%. Auth. states anisotropy may exist

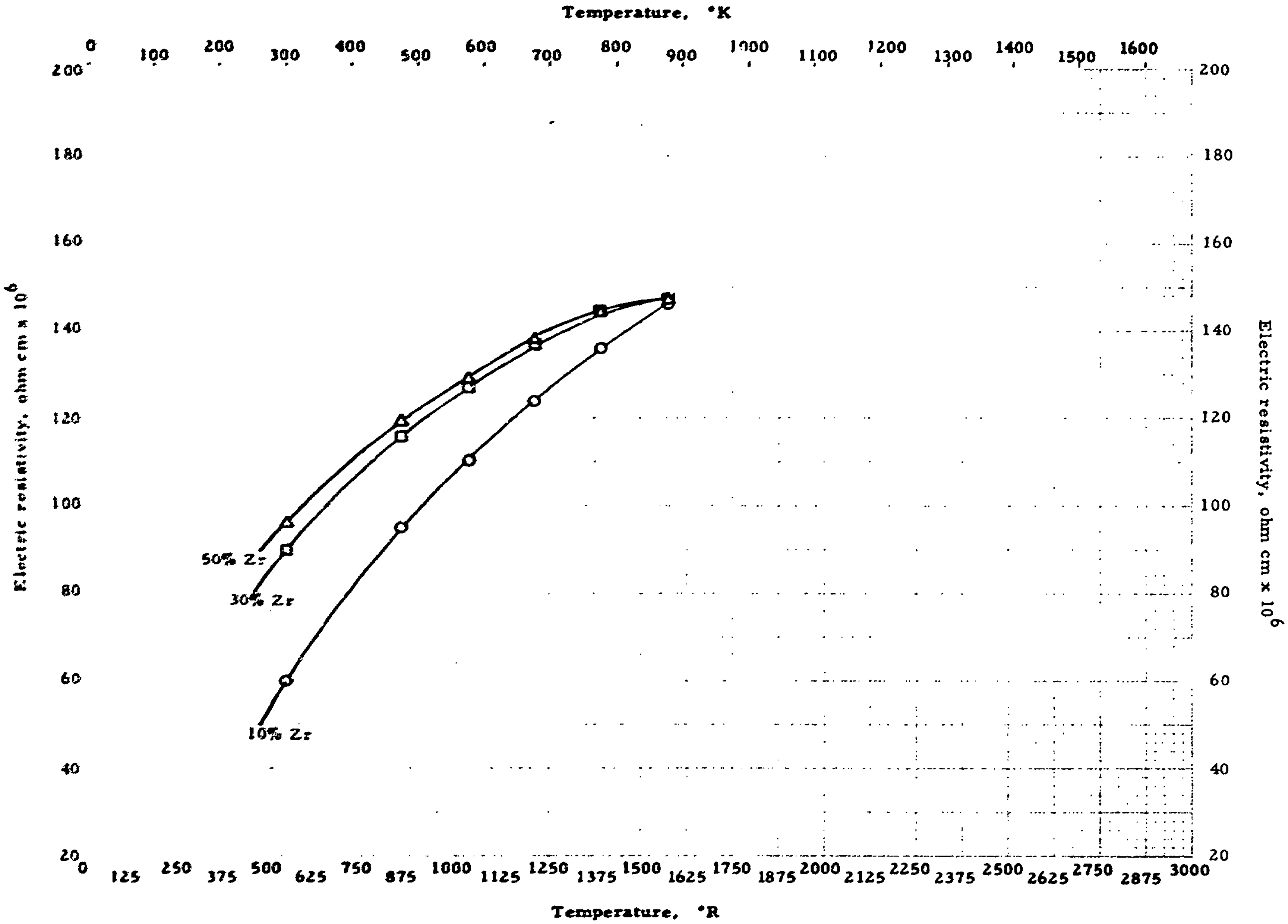


ELECTPIC RESISTIVITY -- TITANIUM + TIN

ELECTRIC RESISTIVITY -- TITANIUM + TIN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S. L. and McQuillan, A. D.	56-15	492-1932	98% Ti; 2% Sn; α-phase; prepared from iodide refined Ti and 99.99% pure Sn	Double bridge	Auth. est. accuracy ± 1%; states anisotropy may exist. Tested in vacuum
□	Ibid.	56-15	492-1932	97% Ti; 3% Sn; α-phase; raw materials same as above	Same as above	Same as above
△	Ibid.	56-15	492-1932	95% Ti; 5% Sn; α-phase; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-15	492-1932	94% Ti; 6% Sn; α-phase; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-15	492-1932	92% Ti; 8% Sn; α-phase; raw materials same as above	Same as above	Same as above

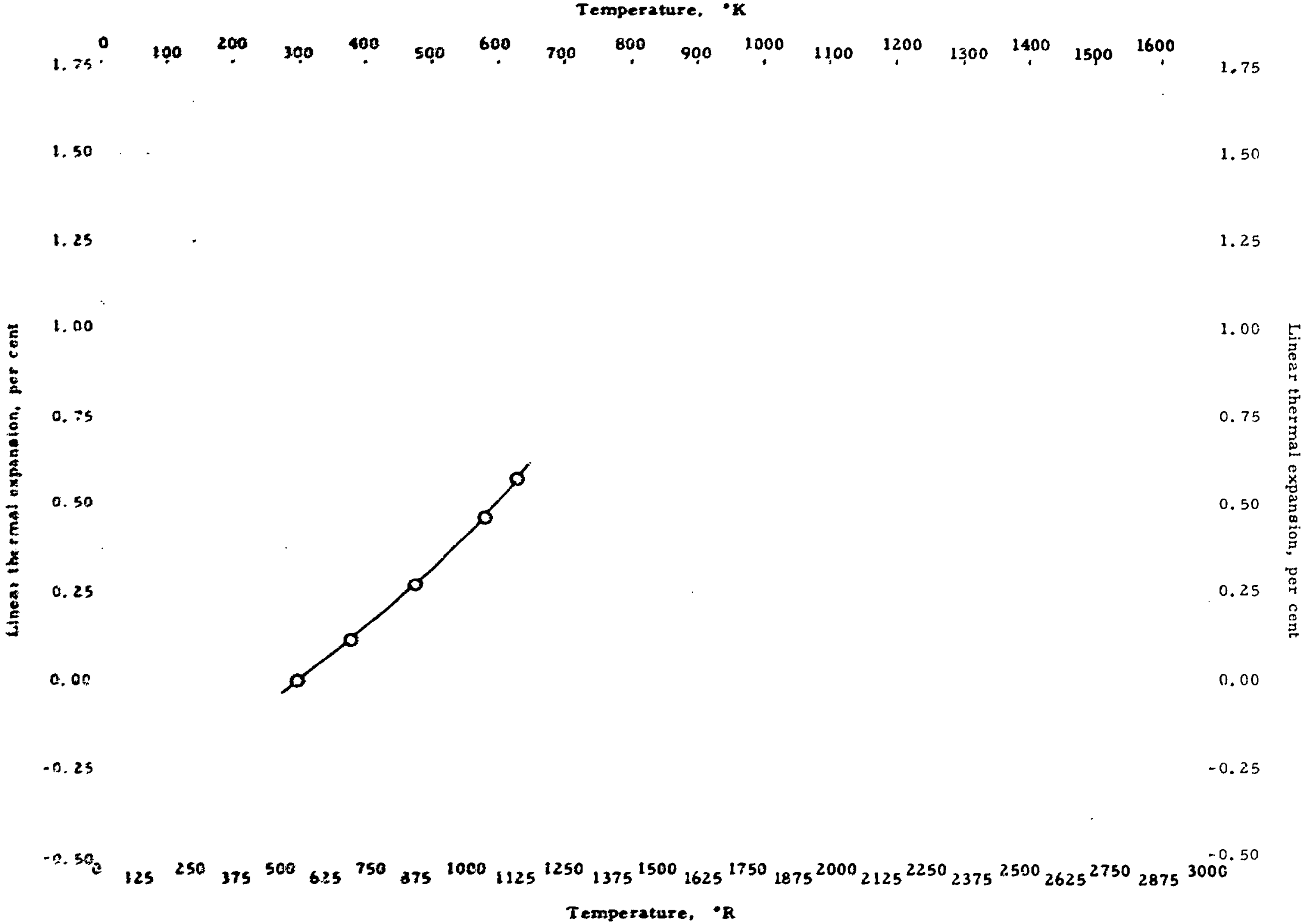


ELECTRIC RESISTIVITY -- TITANIUM + ZIRCONIUM

ELECTRIC RESISTIVITY -- TITANIUM + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Ames, S. L. and McQuillan, A. D.	56-15	537-1572	90% Ti; 10% Zr; α-phase; prepared from iodide refined Ti and iodide refined Zr (containing ~ 2.5% Hf)	Double bridge	Auth. est. accuracy ±1%
□	Ibid.	56-15	537-1572	70% Ti; 30% Zr; α-phase; raw materials same as above	Same as above	Same as above
△	Ibid.	56-15	537-1572	50% Ti; 50% Zr; α-phase; raw materials same as above	Same as above	Same as above



LINEAR THERMAL EXPANSION -- BERYLLIUM + ALUMINUM + X

LINEAR THERMAL EXPANSION -- BERYLLIUM + ALUMINUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hidnert, P. and Krider, H.S.	52-70	528-1122	71.3% Be; 27.9% Al; 0.5% Mg; 0.25% Fe; <0.04% Si	Telemicroscopes sighting on wires suspended from sample	Cast in iron mold

PROPERTIES OF GOLD + CADMIUM

MOST PROBABLE VALUES *

Property	Brit. Engineering Units	C. G. S. Units
Density.	868 lb_m/ft^3	13.9 g/cm^3
Melting Point	1620°R	900°K
Heat of Fusion	25 Btu/lb_m	14 cal/g
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* For nominal AuCd

REPORTED VALUES

Density:

		lb_m/ft^3	g/cm^3
	○	871.5	13.96
	□	904.6	14.49
	△	868.44	13.911

Melting Point:

		°R	°K
	◇	1620	900

Heat of Fusion:

		Btu/lb_m	cal/g
	◇	24.9 ± 1.4	13.8 ± 0.8

Heat of Vaporization:

	Btu/lb_m	cal/g

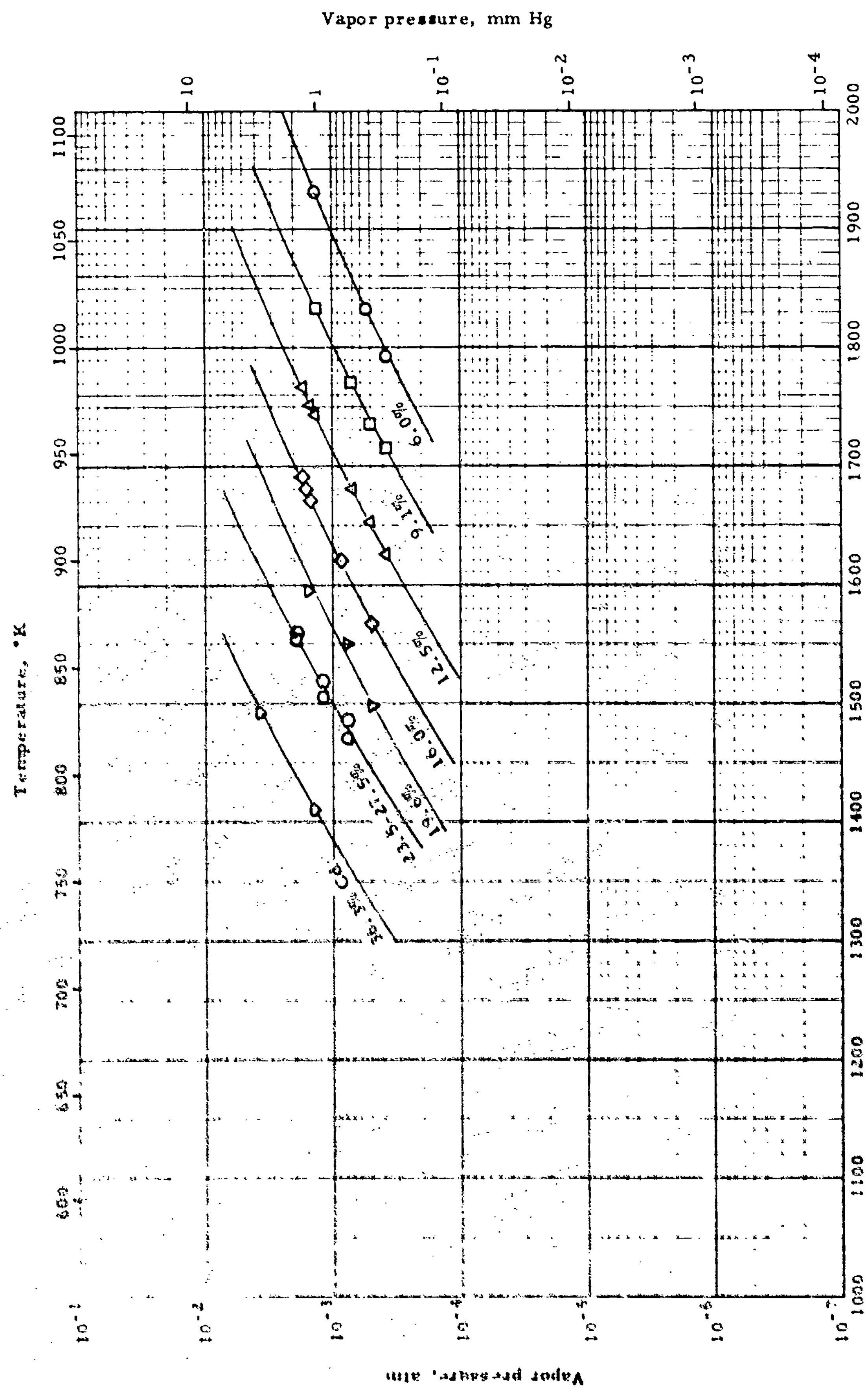
Heat of Sublimation:

	Btu/lb_m	cal/g

PROPERTIES OF GOLD + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Lieberman, D. S.	54-79	537	35.4 - 36.5% Cd; cubic phase	ρ: pycnometer	
□	Ibid.	54-79	573	35.4 - 36.5% Cd; tetragonal phase	ρ: same as above	
△	Sturm, W. J., and Wechsler, M. S.	57-78	Room	35.4% Cd	ρ: weight in air and in acetylene tetrabromide	Quenching from 500°C, decreased density 0.03%
◇	Kubaschewski, O.	43-13	1620	36.3% Cd; β phase	MP: not given; Δh_f: enthalpy above and below MP by drop method into copper block calorimeter	

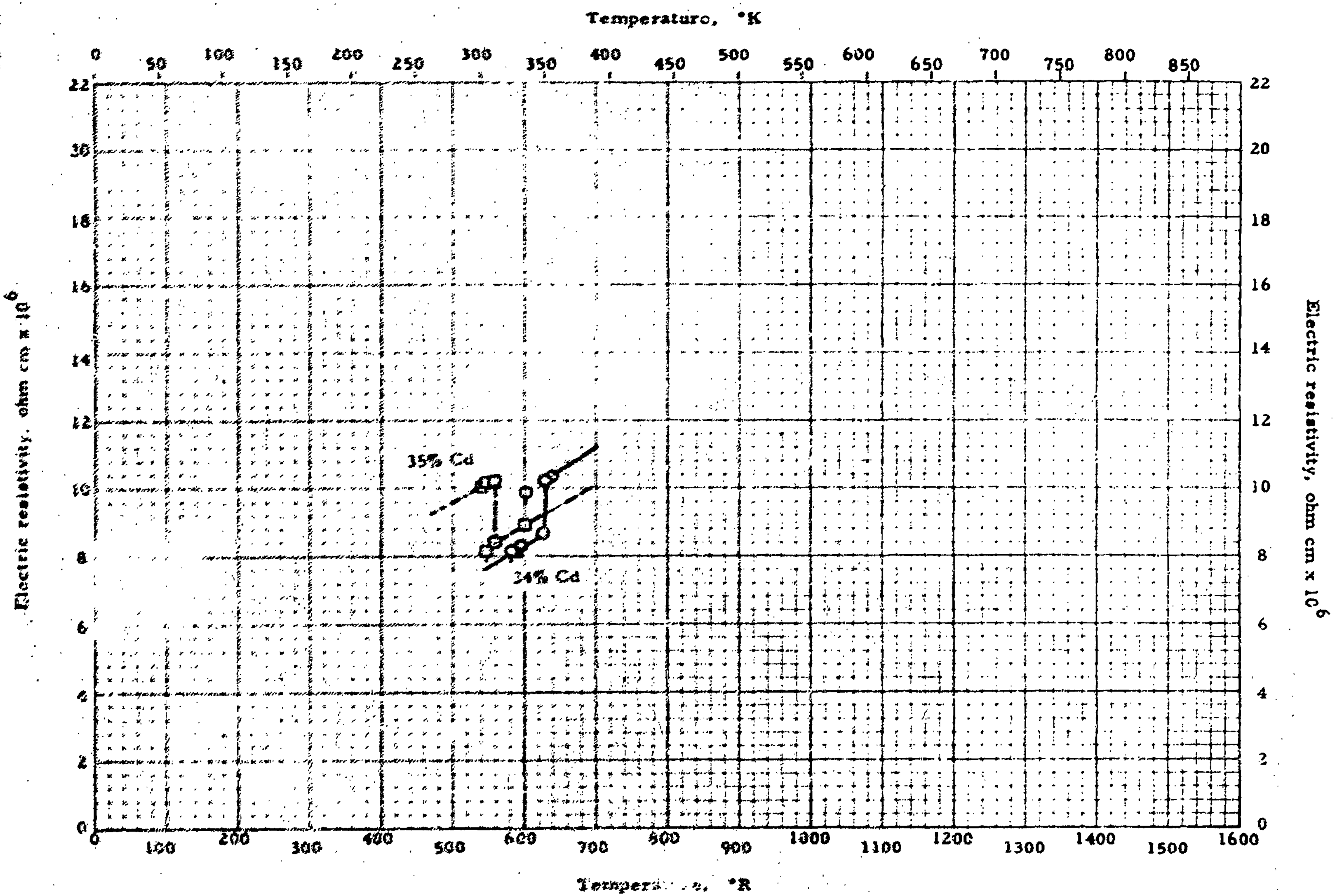


VAPOR PRESSURE -- GOLD + CADMIUM

VAPOR PRESSURE -- GOLD + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Herasymenko, P.	55-65	1793-1932	5.0% Cd α phase	Initially pure; all wires soaked to equilibrium in a constant pressure of Cd vapor; final composition of wire determined	Data are pressure of Cd vapor over the alloy
□	Ibid.	55-65	1793-1932	9.1% Cd; α phase	Same as above	Same as above
△	Ibid.	55-65	1793-1932	12.5% Cd; α phase	Same as above	Same as above
◇	Ibid.	55-65	1793-1932	16.0% Cd. α phase	Same as above	Same as above
▽	Ibid.	55-65	1793-1932	19.6% Cd. α phase	Same as above	Same as above
○	Ibid.	55-65	1793-1932	23.5% Cd; α phase	Same as above	Same as above
⌂	Ibid.	55-65	1793-1932	27.5% Cd. $\alpha + \beta$ phase	Same as above	Same as above
▽	Ibid.	55-65	1793-1932	36.3% Cd; β phase	Same as above	Same as above



ELECTRIC RESISTIVITY -- GOLD + CADMIUM

ELECTRIC RESISTIVITY -- GOLD + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Leiberman, D.S.	54-79	582-636	65.97% Au; 34.03% Cd	Potential drop	Vac. melted from 99.95% pure Ag and 99.99% pure Cd, grown into single crystal ○ - heating ♀ - cooling
□	Ibid.	54-79	541-600	64.61% Au; 35.39% Cd	Same as above	Same as above. □ - third cycle heating ⊓̣ - third cycle cooling

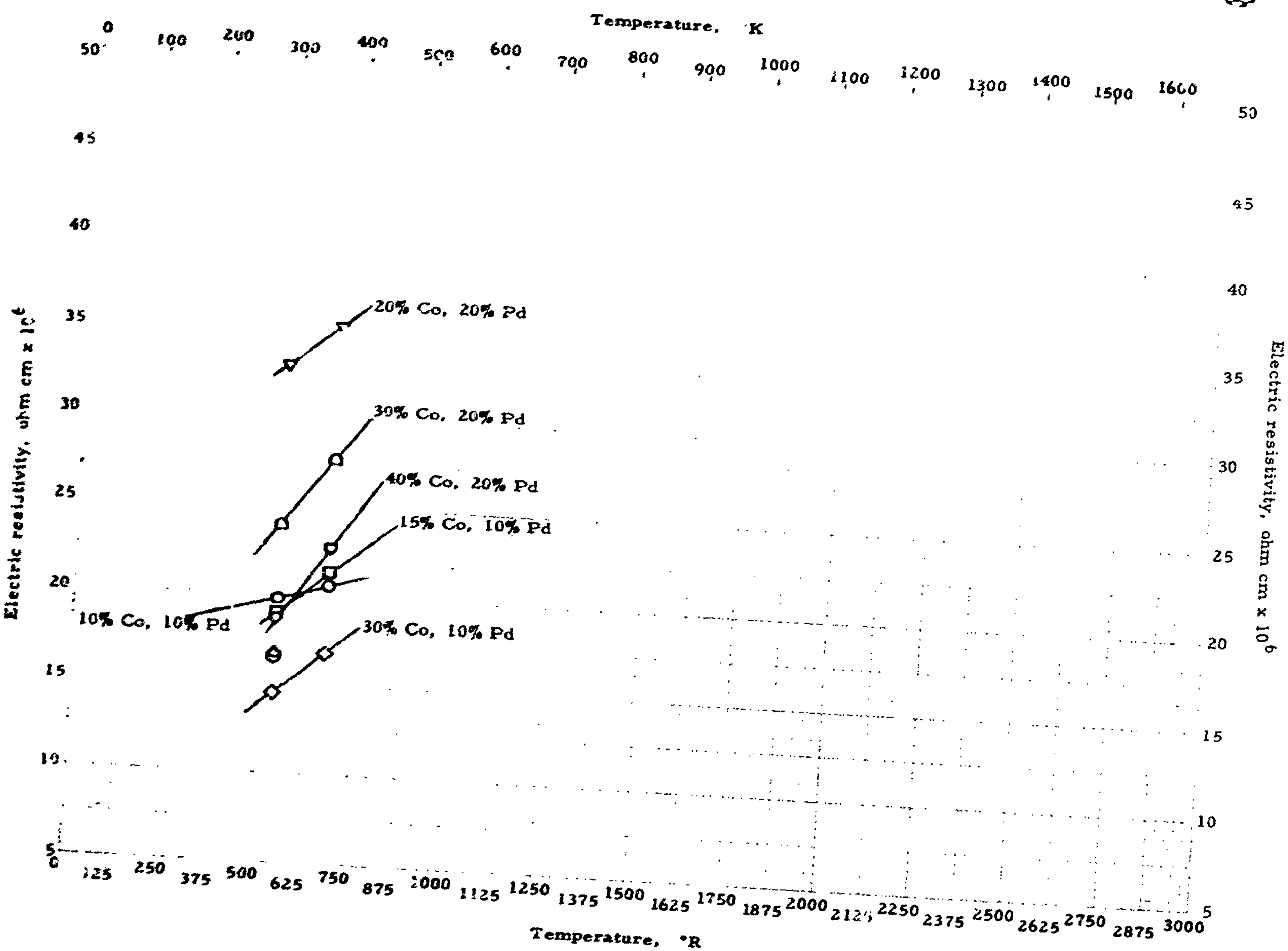
Symbol	Nominal Composition, %			Melting Point	
	Au	Co	Pd	°R	°K
O	80.0	10.0	10.0	2362	1312
	75.0	14.8	10.2	2279	1266
	70.2	19.9	9.9	2333	1296
	60.0	30.0	10.0	2346	1303
	60.0	20.0	20.0	2418	1343
	50.0	40.0	10.0	2567	1315
	50.0	30.0	20.0	2454	1363
	40.0	40.0	20.0	2634	1463

MELTING POINT -- GOLD + COBALT + PALLADIUM

MELTING POINT -- GOLD + COBALT + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Sokolovskaya, E. M., Budennaya, L. D., et al.	56-32	2279-2634	Ternary system: 40-80% Au; 10-40% Co; 9.9-20% Pd. Ingredients with <0.01% impurities	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled

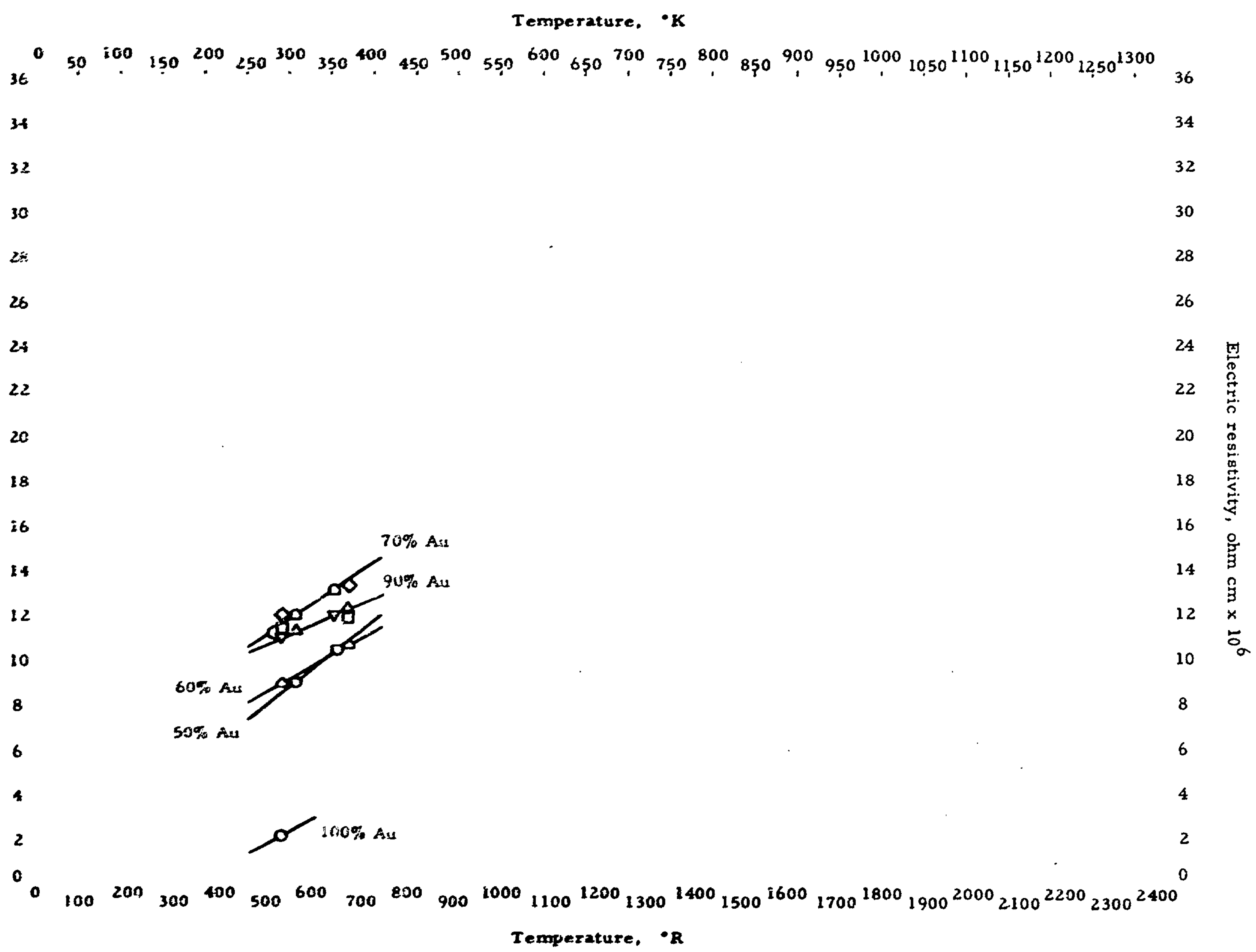


ELECTRIC RESISTIVITY -- GOLD + COBALT + PALLADIUM

ELECTRIC RESISTIVITY -- GOLD + COBALT + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M. et al.	56-32	537-672	80% Au; 10% Co; 10% Pd	Potential drop	Annealed 100-150 hr. close to solidus temp. in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	75% Au; 14.8% Co; 10.2% Pd	Same as above	Same as above
△	Ibid.	56-32	537-672	70.2% Au; 19.9% Co; 9.9% Pd	Same as above	Same as above
◇	Ibid.	56-32	537-672	60% Au; 30% Co; 10% Pd	Same as above	Same as above
▽	Ibid.	56-32	537-672	60% Au; 20% Co; 20% Pd	Same as above	Same as above
○	Ibid.	56-32	537-672	50% Au; 40% Co; 10% Pd	Same as above	Same as above
□	Ibid.	56-32	537-672	50% Au; 30% Co, 20% Pd	Same as above	Same as above
▽	Ibid.	56-32	537-672	40% Au; 40% Co; 20% Pd	Same as above	Same as above



ELECTRIC RESISTIVITY -- GOLD + COBALT

ELECTRIC RESISTIVITY -- GOLD + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolowskaya, E. M. and Maksimova, M. V.	56-125	537-672	99.99% pure Au	Potential drop	Sample prepared by sucking liquid alloy into a porcelain tube. Initial elements 99.99% pure
□	Ibid.	56-125	537-672	96.0% Au; 4.0% Co	Same as above	Same as above
△	Ibid.	56-125	537-672	93.6% Au; 6.4% Co	Same as above	Same as above
◇	Ibid.	56-125	537-672	92.0% Au; 8.0% Co	Same as above	Same as above
▽	Ibid.	56-125	537-672	91.2% Au; 8.8% Co	Same as above	Same as above
○	Ibid.	56-125	537-672	80.0% Au; 20.0% Co	Same as above	Same as above
◠	Ibid.	56-125	537-672	70.2% Au; 29.8% Co	Same as above	Same as above
△	Ibid.	56-125	537-672	60.0% Au; 40.0% Co	Same as above	Same as above
▢	Ibid.	56-125	537-672	51.2% Au; 48.8% Co	Same as above	Same as above

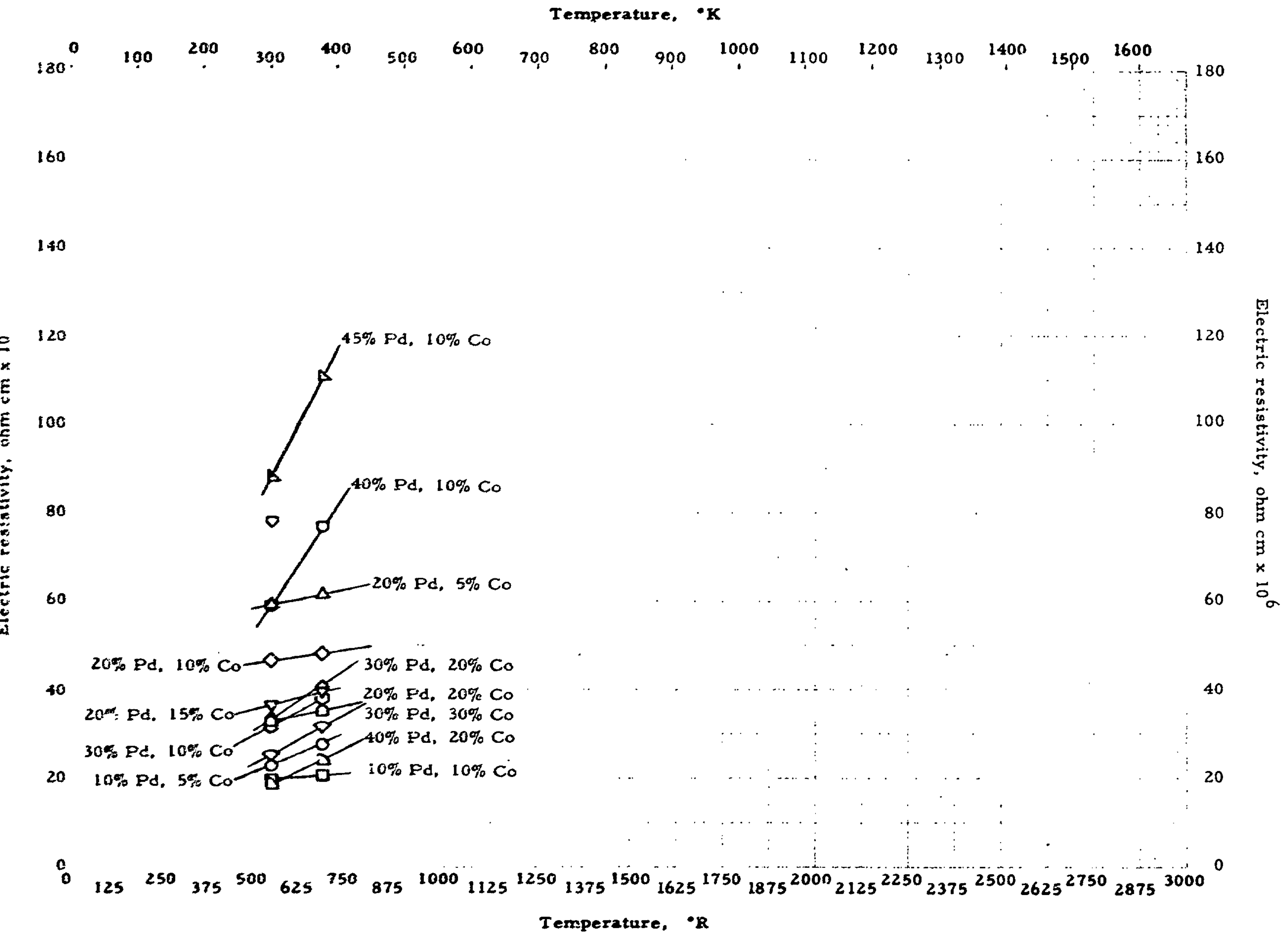
Symbol	Nominal Composition, %			Melting Point	
	Au	Pd	Co	°R	°K
O	85.1	10.1	4.8	2643	1468
	80.0	10.0	10.0	2362	1312
	75.2	20.1	4.7	2799	1555
	70.0	20.0	10.0	2641	1467
	65.0	20.0	15.0	2538	1410
	60.0	30.0	10.0	2725	1514
	60.0	20.0	20.0	2418	1343
	55.2	40.1	4.7	2796	1553
	50.0	40.0	10.0	2652	1473
	50.0	30.0	20.0	2639	1466
	45.0	45.0	10.0	2760	1533
	40.2	30.1	29.7	2652	1473
	40.0	40.0	20.0	2639	1466

MELTING POINT -- GOLD + PALLADIUM + COBALT

MELTING POINT -- GOLD + PALLADIUM + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Sokolovskaya, E. M., Budennaya, L. D. et al.	56-32	2418-2799	Ternary system: 40-85.1% Au; 10-45% Pd; 4.7-29.7% Co. Ingredients with <0.01% impurities	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled

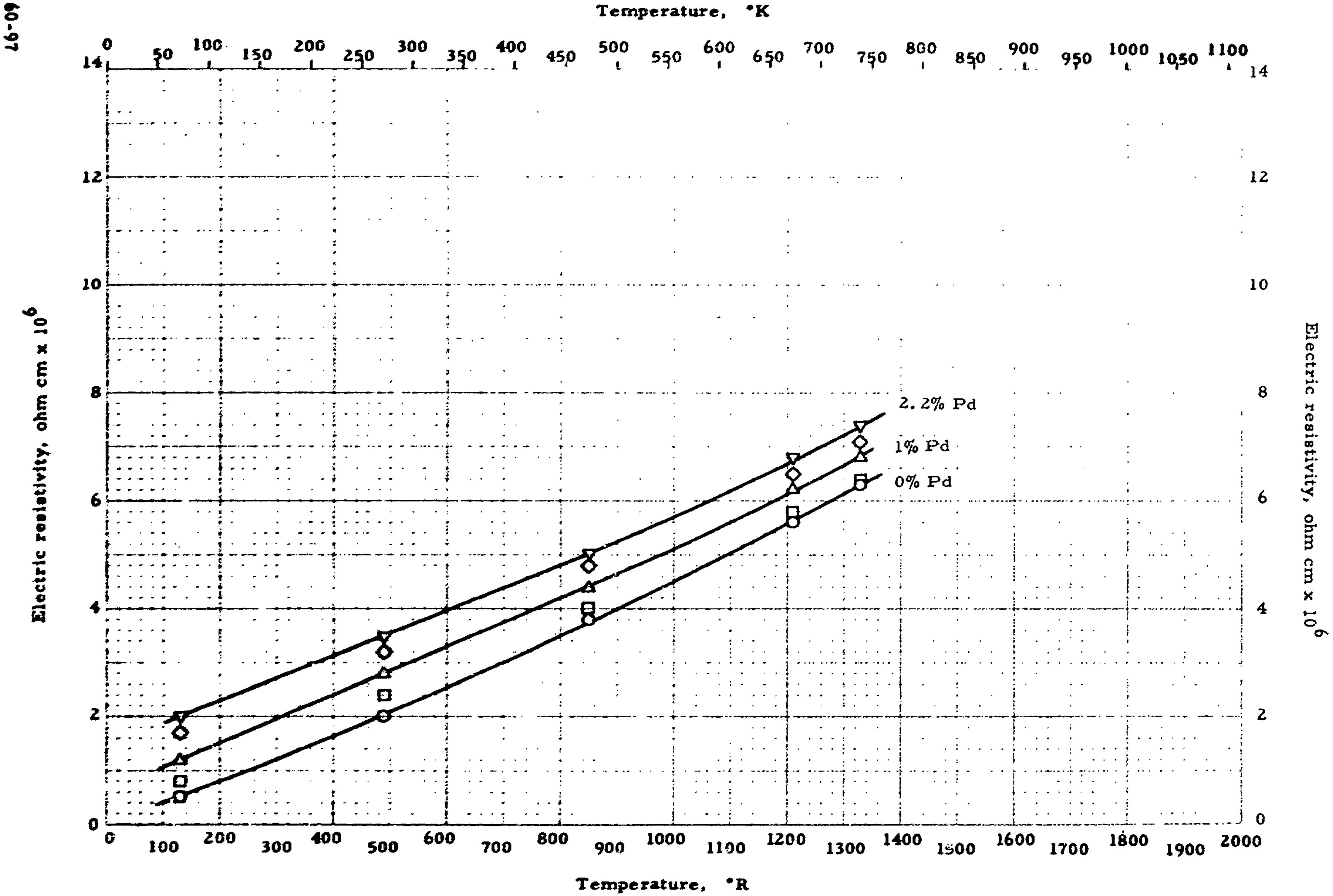


ELECTRIC RESISTIVITY -- GOLD + PALLADIUM + COBALT

ELECTRIC RESISTIVITY -- GOLD + PALLADIUM + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M., et al	56-32	537-672	85.1% Au; 10.1% Pd; 4.8% Co	Potential drop	Annealed 100-150 hr. close to solidus temp. in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	80% Au; 10% Pd; 10% Co	Same as above	Same as above
△	Ibid.	56-32	537-672	75.2% Au; 20.1% Pd; 4.7% Co	Same as above	Same as above
◇	Ibid.	56-32	537-672	70% Au; 20% Pd; 10% Co	Same as above	Same as above
▽	Ibid.	56-32	537-672	65% Au; 20% Pd; 15% Co	Same as above	Same as above
○	Ibid.	56-32	537-672	60% Au; 30% Pd; 10% Co	Same as above	Same as above
□	Ibid.	56-32	537-672	60% Au; 20% Pd; 20% Co	Same as above	Same as above
▽	Ibid.	56-32	537-672	55.2% Au; 40.1% Pd; 4.7% Co	Same as above	Same as above
□	Ibid.	56-32	537-672	50% Au; 40% Pd; 10% Co	Same as above	Same as above
△	Ibid.	56-32	537-672	50% Au; 30% Pd; 20% Co	Same as above	Same as above
△	Ibid.	56-32	537-672	45% Au; 45% Pd; 10% Co	Same as above	Same as above
◇	Ibid.	56-32	537-672	40.2% Au; 30.1% Pd; 29.7% Co	Same as above	Same as above
△	Ibid.	56-32	537-672	40% Au; 40% Pd; 20% Co	Same as above	Same as above



ELECTRIC RESISTIVITY -- GOLD + PALLADIUM

ELECTRIC RESISTIVITY -- GOLD + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F. A.	56-46	132-1932	99.99% pure gold	Potential drop	Heated to 100°C above MP, homogenized 24 hr. at 900°C, swaged, annealed 1 hr. at 500°C
□	Ibid.	56-46	132-1932	0.44% Pd; prepared from 99.99% pure raw materials	Same as above	Same as above
△	Ibid.	56-46	132-1932	1.0% Pd; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-46	132-1932	1.7% Pd; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-46	122-1932	2.2% Pd; raw materials same as above	Same as above	Same as above

PROPERTIES OF GOLD + NICKEL

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density, 10.26% Ni . . .	106. lb_m/ft^3	17.06 g/cm^3
Melting Point, 10% Ni . .	2220 °R *	1230 °K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11).

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	O	1128	18.07
	□	1065	17.06

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

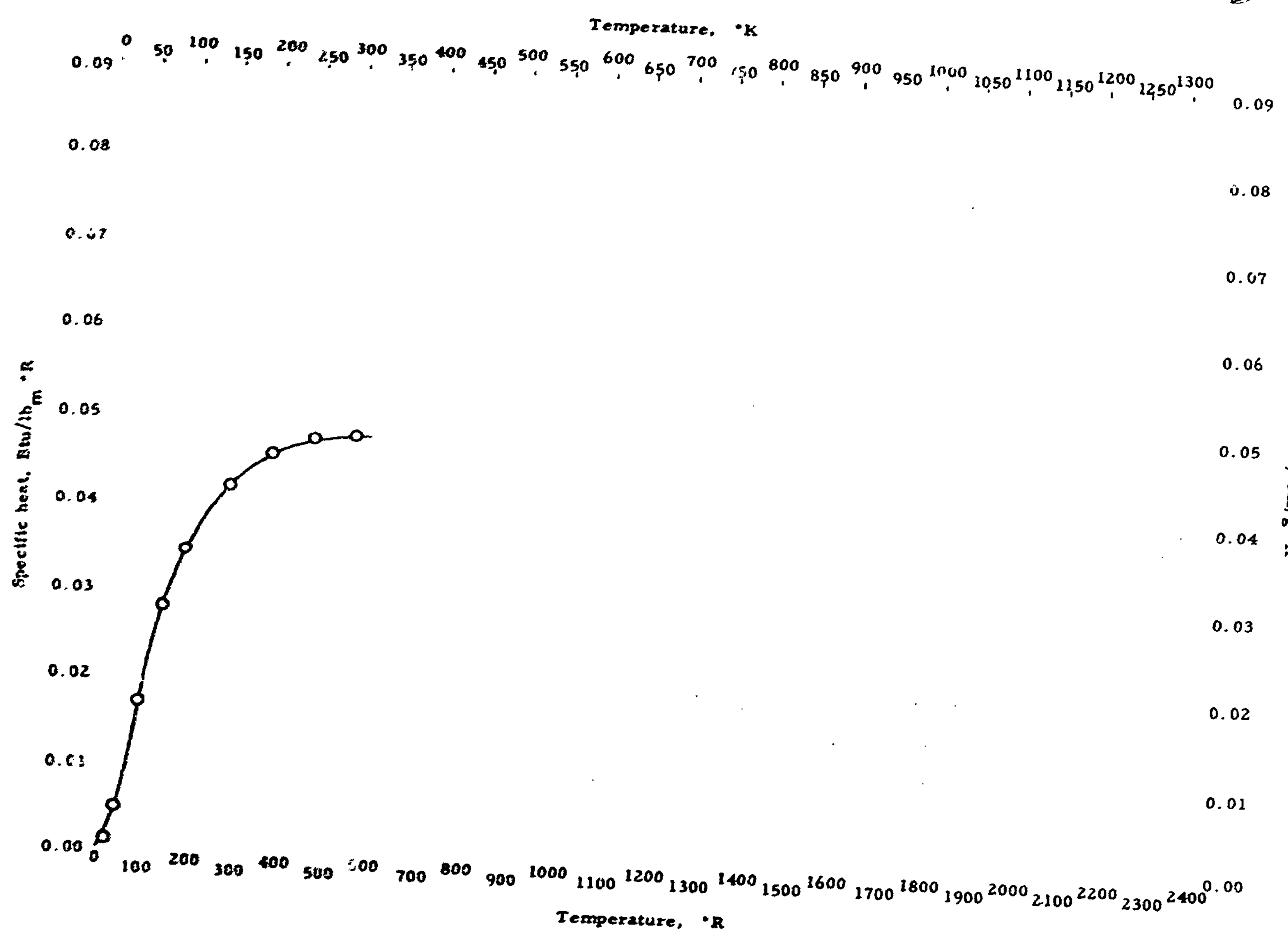
	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF GOLD + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Seybold, A. U.	43-18	Room	94.87% Au; [illegible].13% Ni	ρ: not given	Melted Au in H_2 atm., added Ni, cast, remelted, quenched from 850 °C
□	Ibid.	43-18	Room	89.74% Au; 10.26% Ni	ρ: not given	same as above

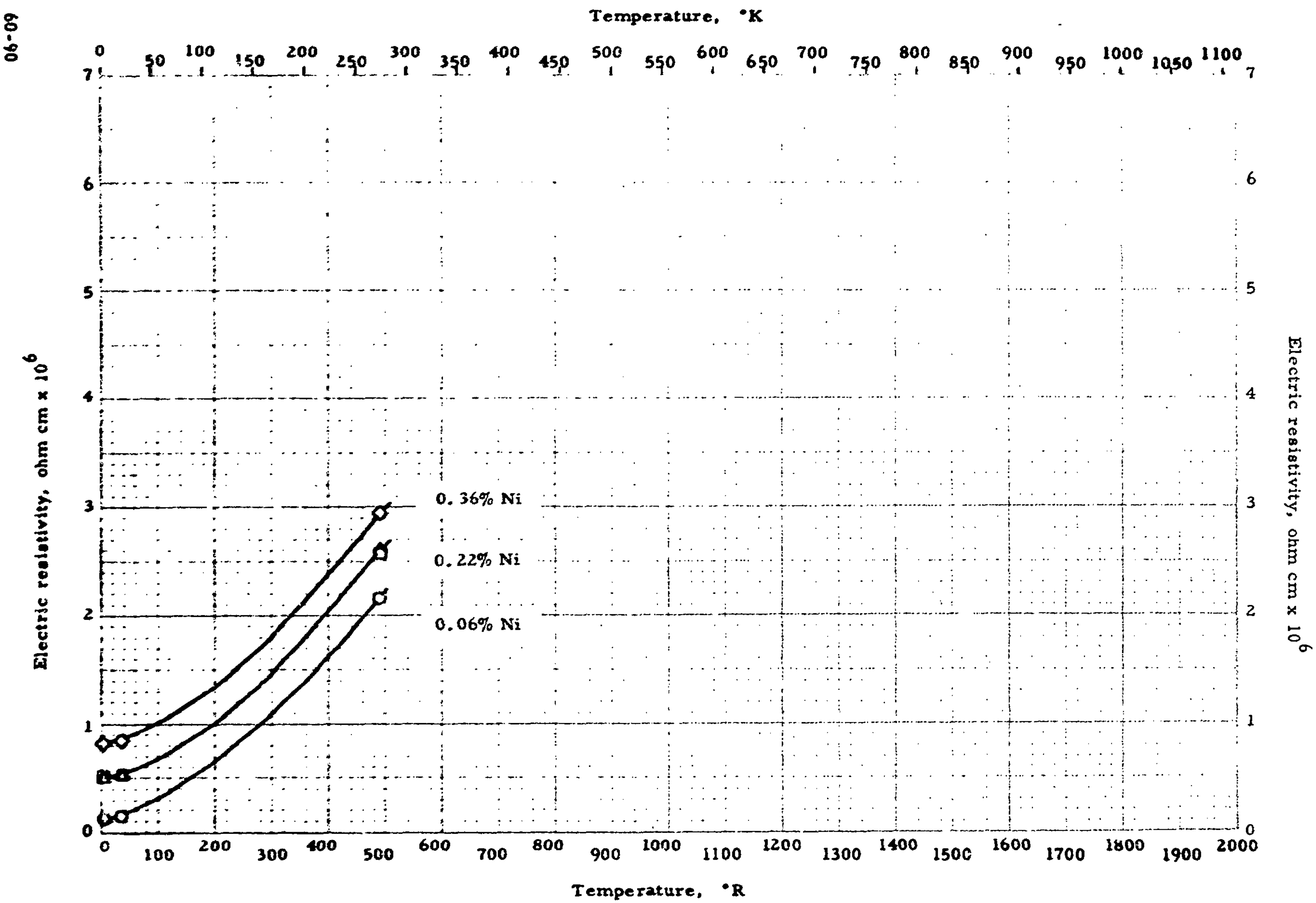


SPECIFIC HEAT -- GOLD + NICKEL

SPECIFIC HEAT -- GOLD + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Desorbo, W.	55-35	28-540	78.24% Au; 21.76% Ni	Guarded sample	Machined filings homogenized by heating several hr. at approx. 900° C, water quenched



ELECTRIC RESISTIVITY -- GOLD + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Los, G. J.	57-132	2.3-492	99.94% Au; 0.06% Ni	Not described here, refers to others	Prepared from pure components in vacuum:
□	Ibid.	57-132	2.3-492	99.79% Au; 0.21% Ni	Same as above	Same as above
△	Ibid.	57-132	2.3-492	99.78% Au; 0.22% Ni	Same as above	Same as above
◇	Ibid.	57-132	2.3-492	99.64% Au; 0.36% Ni	Same as above	Same as above

PROPERTIES OF GOLD + MANGANESE + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 9% Mn	990 lb_m/ft^3	15.9 g/cm^3
Melting Point 9% Mn . .	2220 °R *	1230 °K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	O	990	15.86

	°R	°K
Melting Point:		

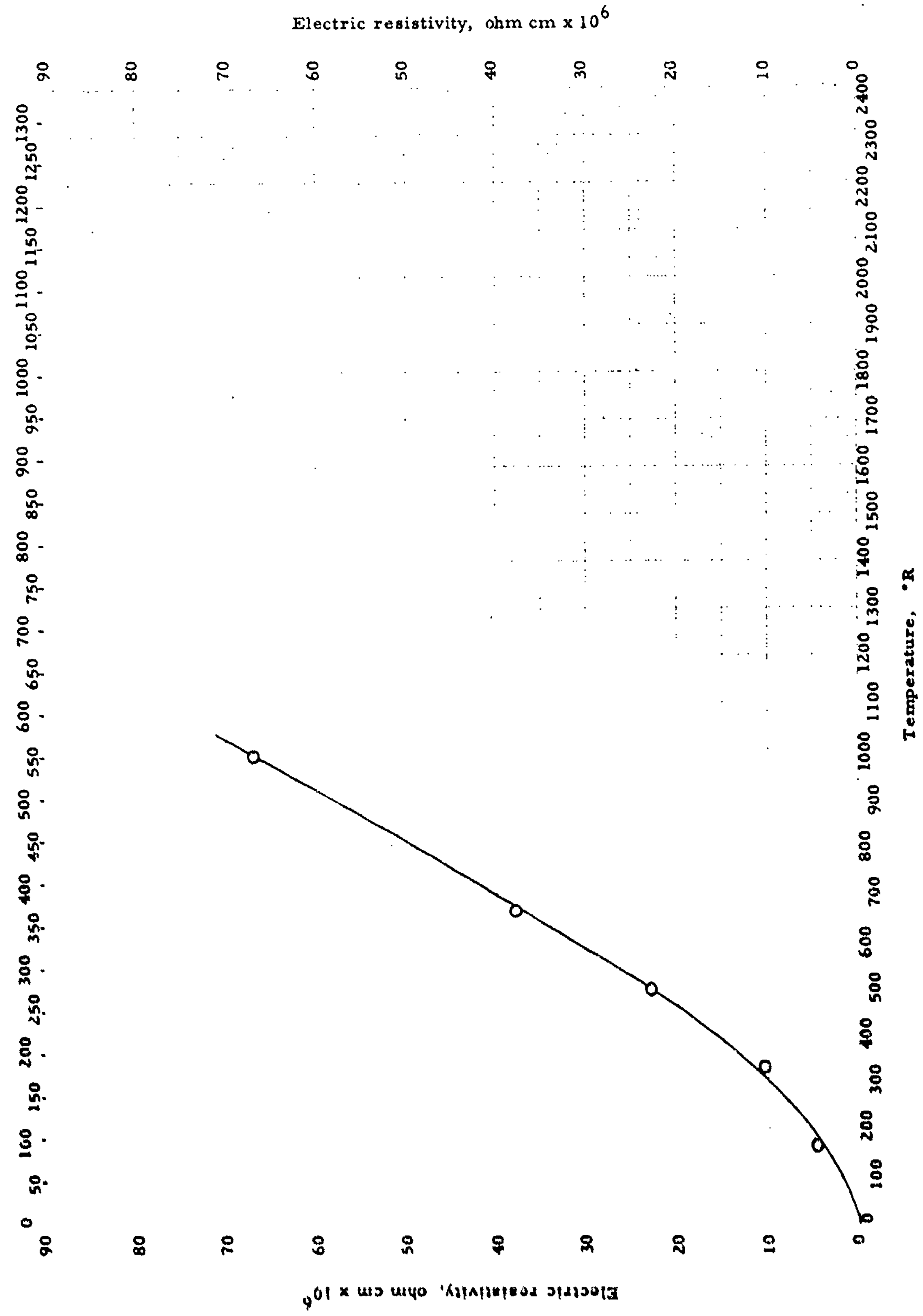
	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Seybold, A. U.	43-18	Room	91.41% Au; 8.59% Mn	ρ: not given	Melted Au in H_2 atm., added Mn, cast, remelted, quenched from 850 °C

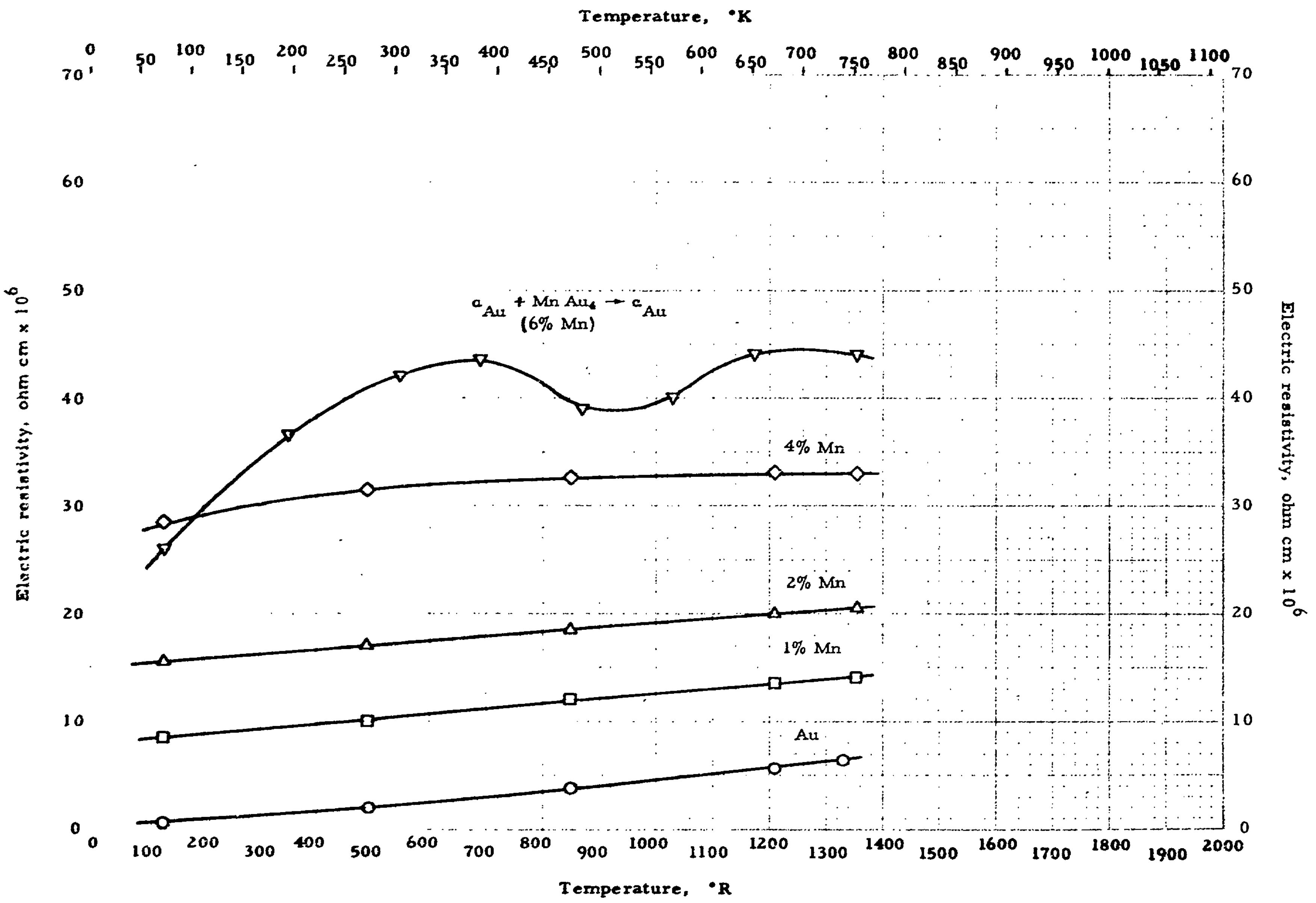


ELECTRIC RESISTIVITY -- GOLD + MANGANESE (Au_2Mn)

ELECTRIC RESISTIVITY -- GOLD + MANGANESE (Au_2Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Smith, J.H. and Street, R.	57-106	165-988	Au_2Mn. Spectroscopically pure	Not given	Melted in induction furnace 90 hr. at 690°C; water quenched



ELECTRIC RESISTIVITY -- GOLD + MANGANESE

ELECTRIC RESISTIVITY -- GOLD + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F.A.	56-46	132-1392	99.99% pure gold	Potential drop	Heated to 100 °C above MP in vac. homogenized 24 hr. at 900 °C, swaged, annealed 1 hr. at 500 °C
□	Ibid.	56-46	132-1392	1.00% Mn; prepared from 99.99% pure raw materials	Same as above	Same as above
△	Ibid.	56-46	132-1392	2.00% Mn; raw materials same as above	Same as above	Same as above
◇	Ibid.	56-46	132-1392	4.00% Mn; raw materials same as above	Same as above	Same as above
▽	Ibid.	56-46	132-1392	6.00% Mn; raw materials same as above	Same as above	Same as above

PROPERTIES OF GOLD + IRON

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 9.86% Fe	1017 lb_m/ft^3	16.29 g/cm^3
Melting Point 10% Fe . .	2350°R *	1305°K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	O	1017	16.29

Melting Point: °R °K

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF GOLD + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Seybold, A. U.	43-18	Room	90.14% Au; 9.86% Fe	ρ: not given	Melted Au in H_2 atm., added Fe, cast, remelted, quenched from 850°C

PROPERTIES OF GOLD + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 9.32% U	1160 lb_m/ft^3	18.6 g/cm^3
Melting Point 9% U . . .	2030 °R *	1130 °K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	O	1161	18.60

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF GOLD + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Seybold, A. U.	43-18	Room	90.68% Au; 9.32% U	ρ: not given	Melted Au in H_2 atm., added U, cast, remelted, quenched from 850 °C

PROPERTIES OF GOLD + ZINC

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point	1860°R *	1033°K *
Heat of Fusion	40.3 Btu/lb_m *	22.4 cal/g *
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Values for 24.9% Zn.

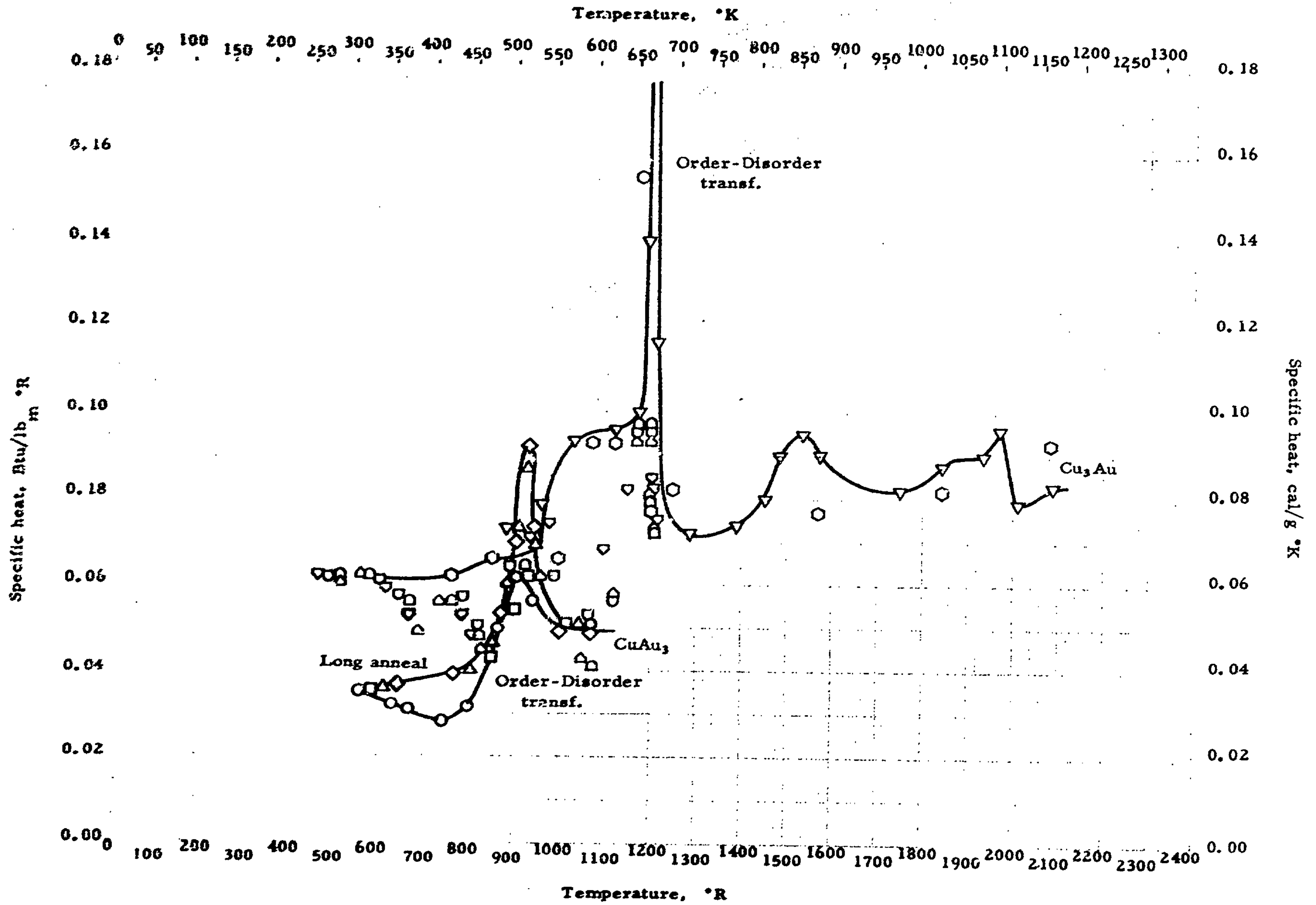
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	1860	1033
Heat of Fusion:		Btu/lb_m	cal/g
	O	40.3 ± 1.8	22.4 ± 1
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF GOLD + ZINC

REFERENCE INFORMATION

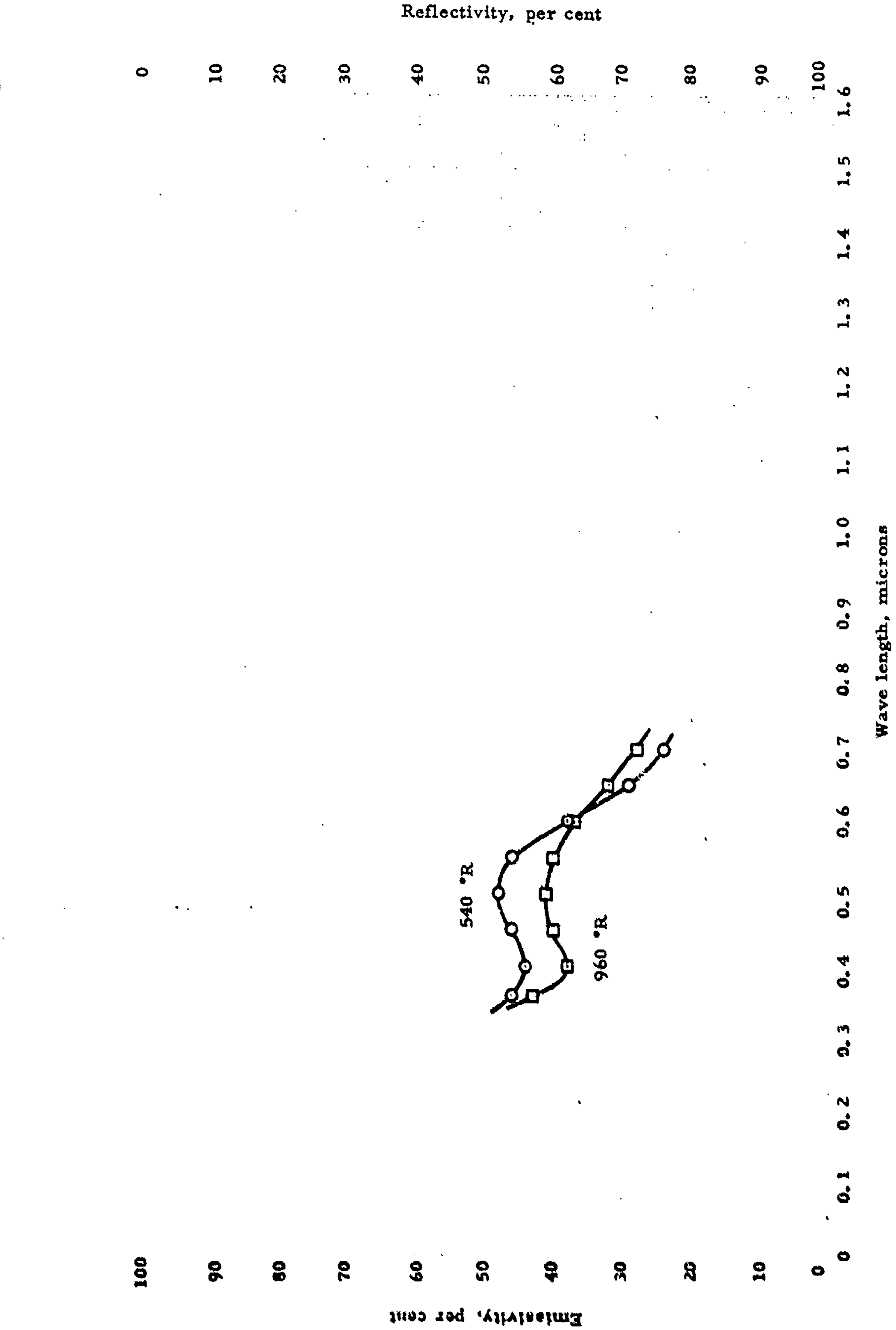
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubaschewski, O.	43-13	1860	24.9% Zn, β phase	MP: not given; Δh_f: from enthalpy data above and below MP by drop method into copper calorimeter	



SPECIFIC HEAT -- GOLD + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hirabayashi, M.	52-29 51-35	564-1032	89.8% Au; 10.2% Cu ($CuAu_3$)	Not given	Reheated slowly after water quench from 600°C
□	Ibid.	52-29 51-35	564-1032	Same as above	Same as above	Air cooled before reheating
△	Ibid.	52-29 51-35	564-1032	Same as above	Same as above	Annealed at 180°C for several days
◇	Ibid.	52-29 51-35	564-1032	Same as above	Same as above	Same as above
▽	Kuczyniski, G.C., Doyama, M. and Fine, M.E.	56-55	888-2112	Cu_3Au. Made of 99.98% pure Au and 99.97% pure Cu	Comparative; rate of temp. drop in sample compared with standard under same cooling conditions	Swaged into rods and heat treated just below MP for 10 days
○	Hirabayashi, M., Nagasaki, S. and Kono, H.	57-165	519-2085	50.9% Au; 49.1% Cu (Cu_3Au)	Adiabatic calorimeter at 2°C/min	Ordered. Annealed 3 weeks at 420-200°C
◯	Ibid.	57-165	519-2085	Same as above	Same as above	Quenched from 530°C
△	Ibid.	57-165	519-2085	Same as above	Same as above	Quenched from 600°C
▢	Ibid.	57-165	519-2085	Same as above	Same as above	Quenched from 670°C
▽	Ibid.	57-165	519-2085	Same as above	Same as above	Quenched from 790°C

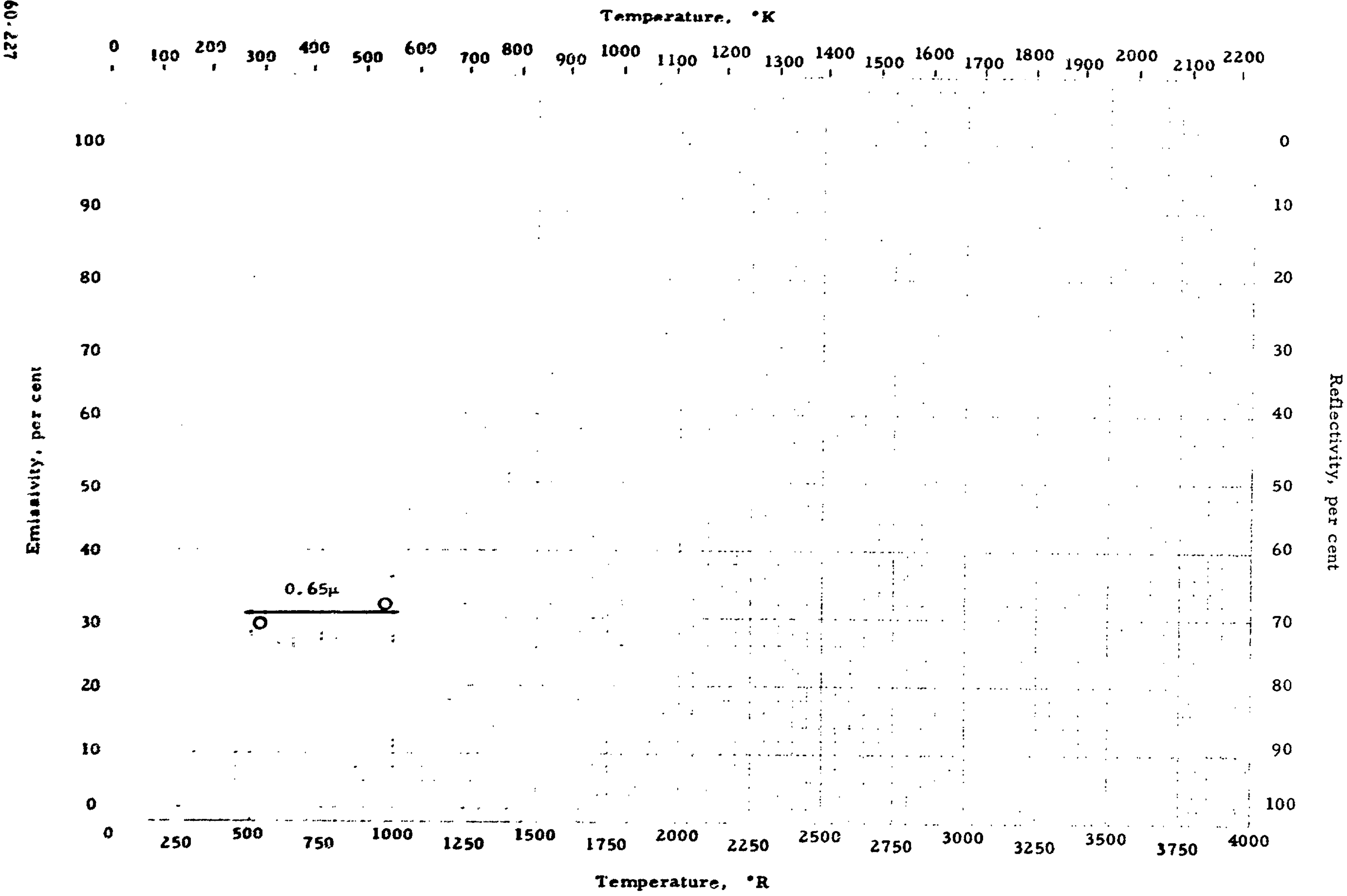


SPECTRAL EMISSIVITY -- GOLD + ZINC

SPECTRAL EMISSIVITY -- GOLD + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Maulawer, L.	57-96	542	75.1% Au; 24.9% Zn	Spectral reflectivity at 18°: Beckman spectrophotometer	Auth. believes data to be low
□	" "	57-96	962	Same as above	Same as above	Same as above

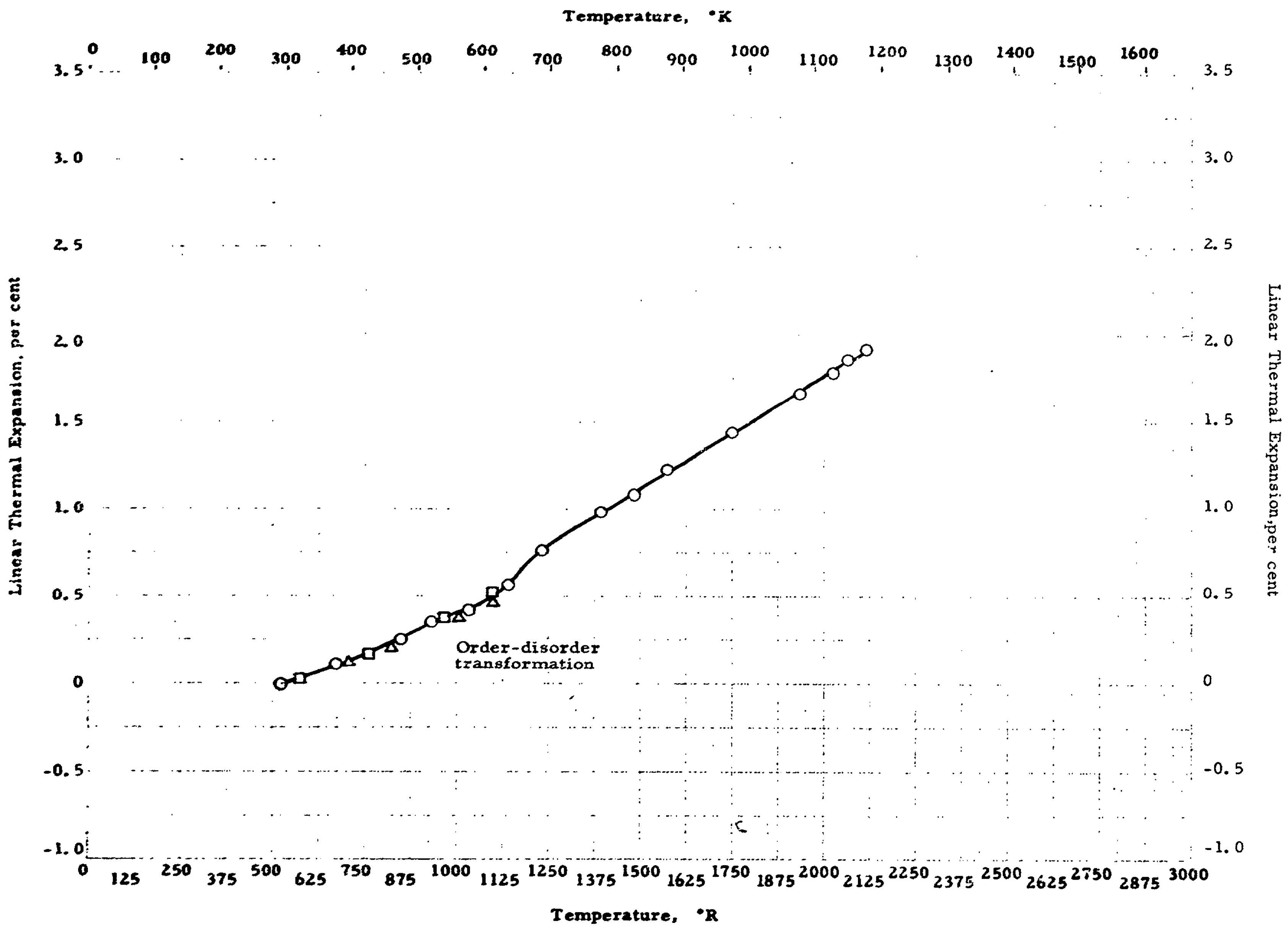


EMISSIVITY -- GOLD + ZINC

EMISSIVITY -- GOLD + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Maulawer, L.	57-96	542-962	75.1% Au; 24.9% Zn	Spectral reflectivity at 0.65μ and 18°: Beckman spectrophotometer	Auth. believes his data to be low

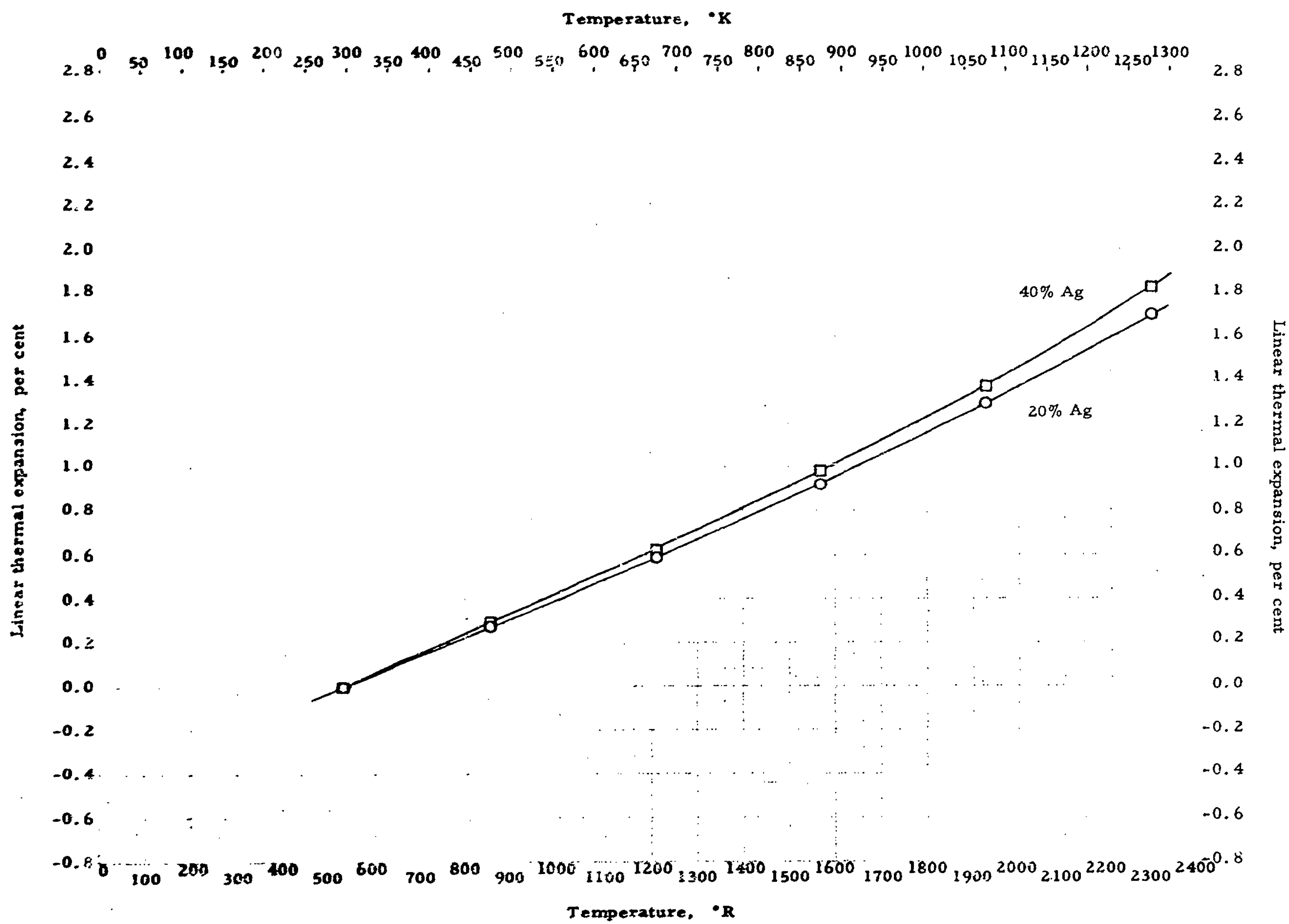


LINEAR THERMAL EXPANSION -- GOLD + COPPER

LINEAR THERMAL EXPANSION -- GOLD + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuczyniski, G. C., Doyama, M. and Fine, M. E.	56-55	528-2112	Cu_3 Au 50.8% Au; 49.2% Cu	Leitz-Bollenrath quartz tube dilatometer	Melted in evacuated quartz tube from 99.986% Au and 99.97% Cu. Swaged into rods, then heat treated 10 days just below melting point.
□	Hirabayashi, M.	52-29	528-1104	Cu Au_3: 90% Au; 10% Cu	Quartz tube dilatometer	Annealed 14 days at 180°C
△	Ibid	52-29	528-1104	Same as above	Same as above	Water quenched from 400°C

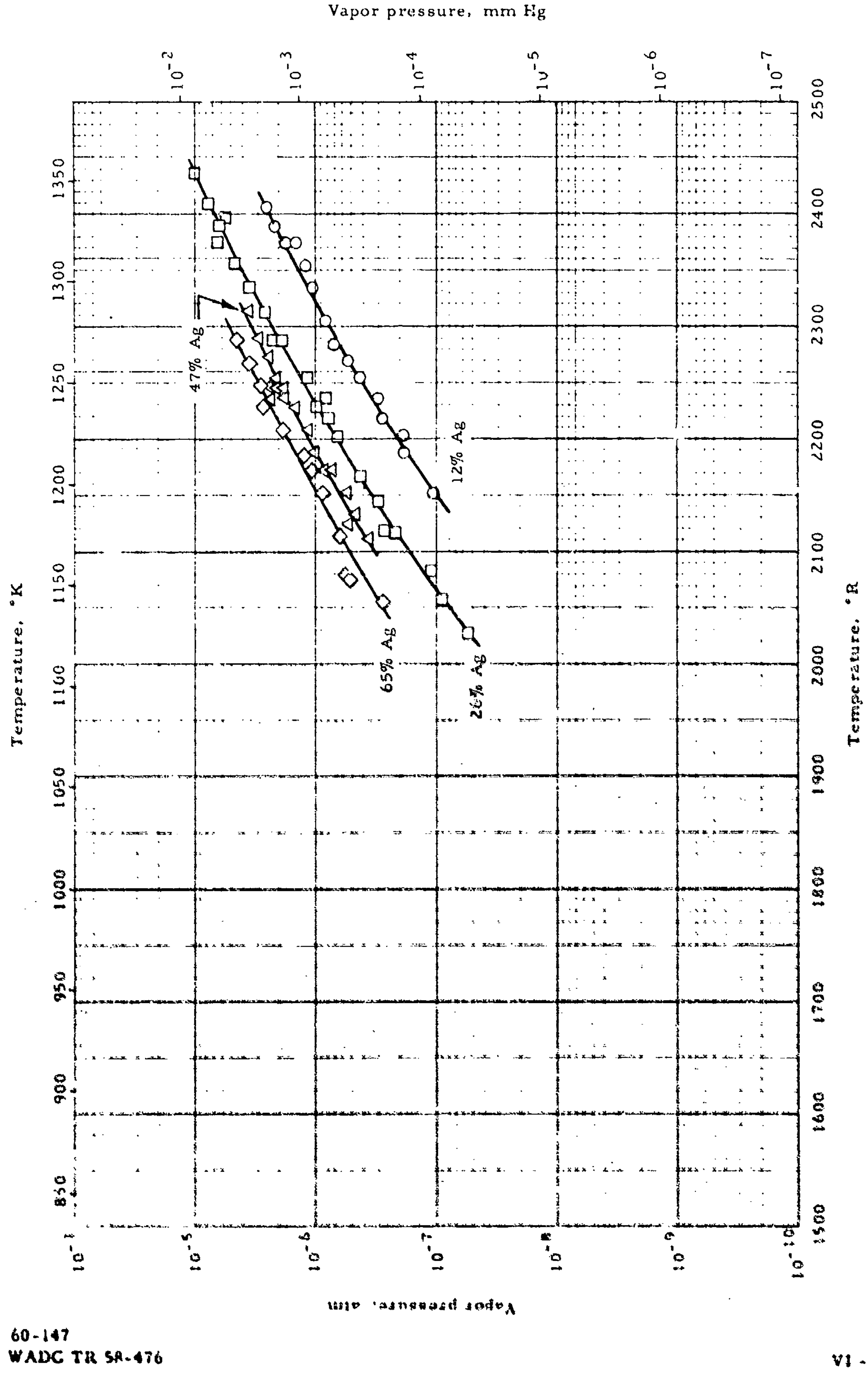


LINEAR THERMAL EXPANSION - - GOLD + SILVER

LINEAR THERMAL EXPANSION -- GOLD + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Gebhardt, E. and Dorner, S.	51-41	528-2292	80% Au, 20% Ag	Dilatometer	Homogenized
□	Ibid.	51-41	528-2295	60% Au; 40% Ag	Same as above	Same as above

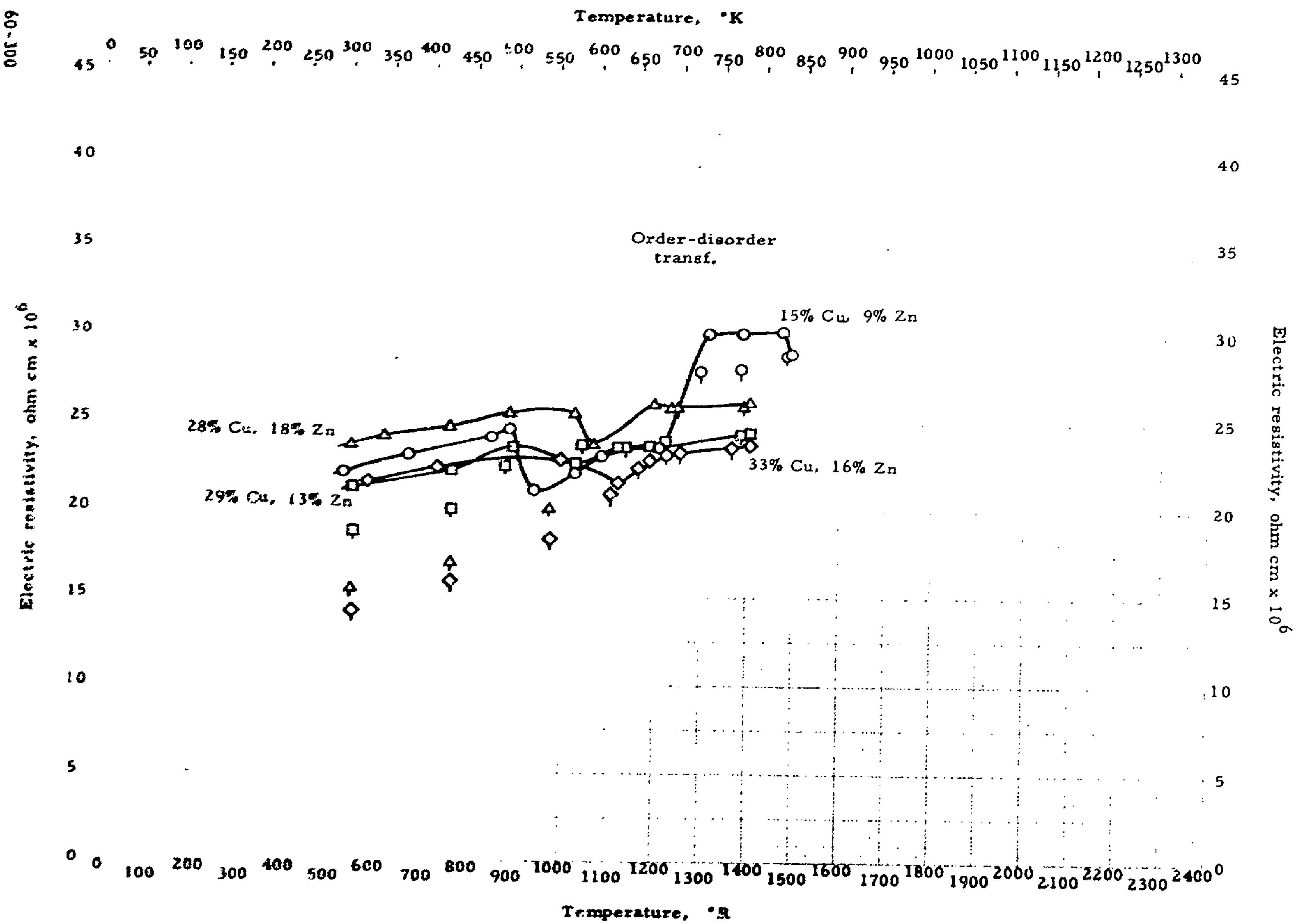


VAPOR PRESSURE -- GOLD + SILVER

VAPOR PRESSURE -- GOLD + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	McCabe, C. L. Schadel Jr. H. M. and Birchenall, C. E.	53-131	2151-2405	88.3% Au; 11.7% Ag	Knudsen effusion cell with radioactive counting. Temp. by vapor pressure of silver	
□	Ibid.	53-131	2029-2437	74.2% Au; 25.8% Ag	Same as above	
△	Ibid.	53-131	2111-2313	52.8% Au; 47.2% Ag	Same as above	
◇	Ibid.	53-131	2054-2288	34.7% Au; 65.3% Ag	Same as above	

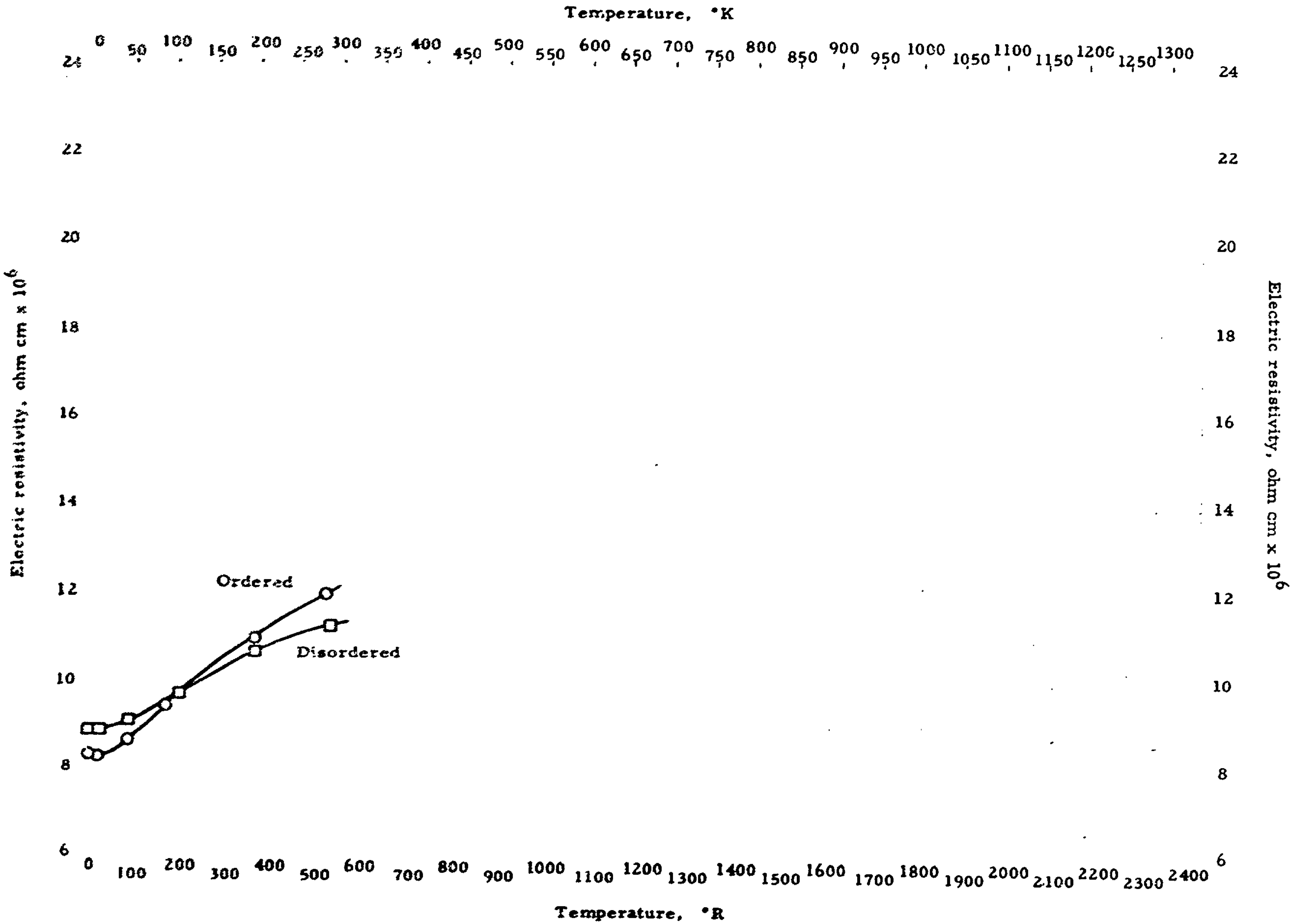


ELECTRIC RESISTIVITY -- GOLD + COPPER + ZINC

ELECTRIC RESISTIVITY -- GOLD + COPPER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Walter, P.	50-57	528-1482	76.08% Au; 15.29% Cu; 8.63% Zn	Not given	○ - Heating curve ⍜ - Cooling curve
□	Ibid.	50-57	546-1410	57.3% Au; 29.4% Cu; 13.3% Zn	Not given	□ - Heating curve □ - Cooling curve
△	Ibid.	50-57	546-1410	53.4% Au; 28.2% Cu; 18.4% Zn	Not given	△ - Heating curve △ - Cooling curve
◇	Ibid.	50-57	546-1410	50.8% Au; 32.8% Cu; 16.4% Zn	Not given	◇ - Heating curve ◇ - Cooling curve

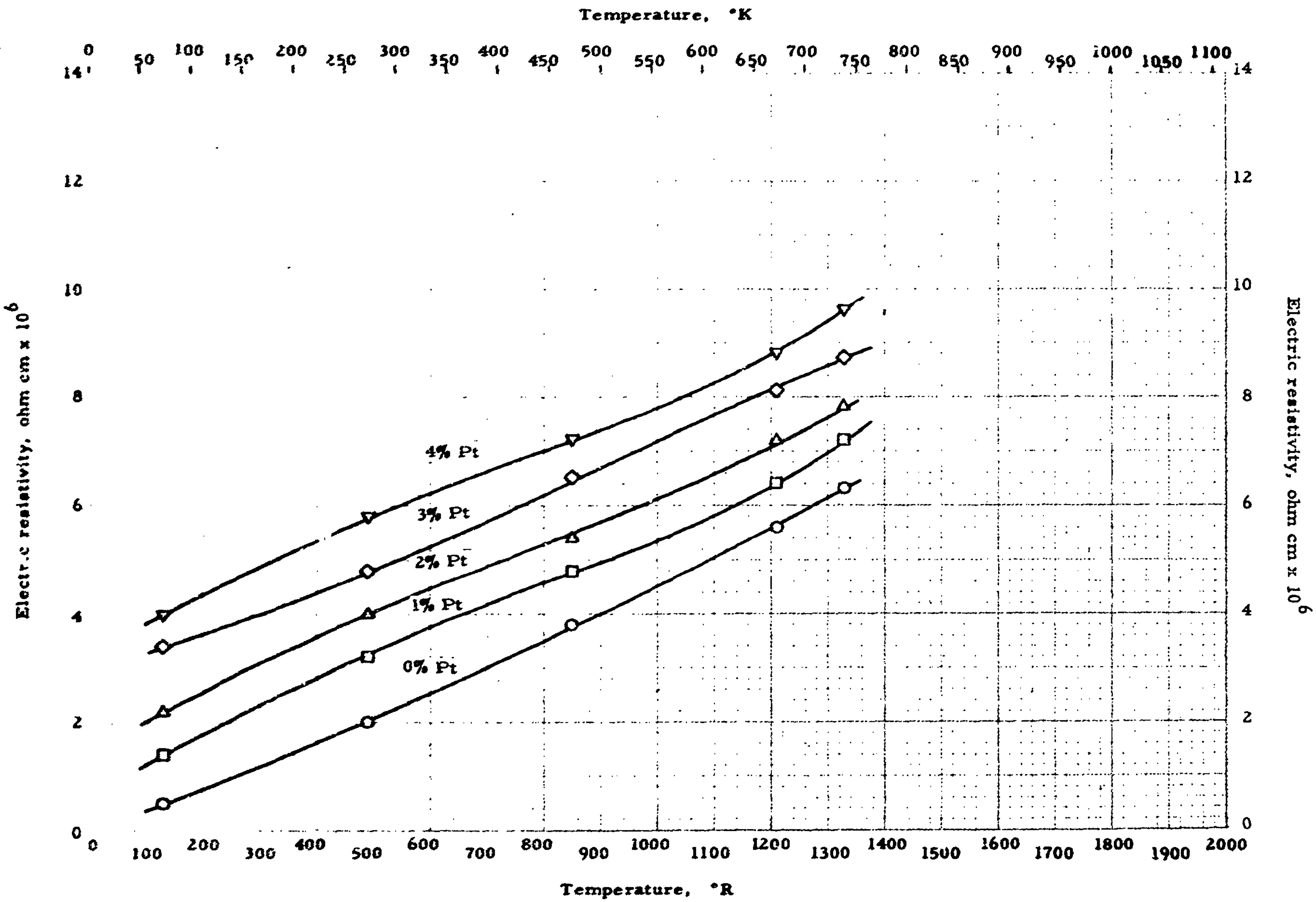


ELECTRIC RESISTIVITY -- GOLD + COPPER

ELECTRIC RESISTIVITY -- GOLD + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Hirabayashi, M. and Muto, Y.	57-162	4-513	90.30% Au	Not given	Ordered state, cooled from 200 °C to room temp. in 4 months
□	Ibid.	57-162	4-522	Same as above	Same as above	Disordered state, quenched from 450 °C in ice water

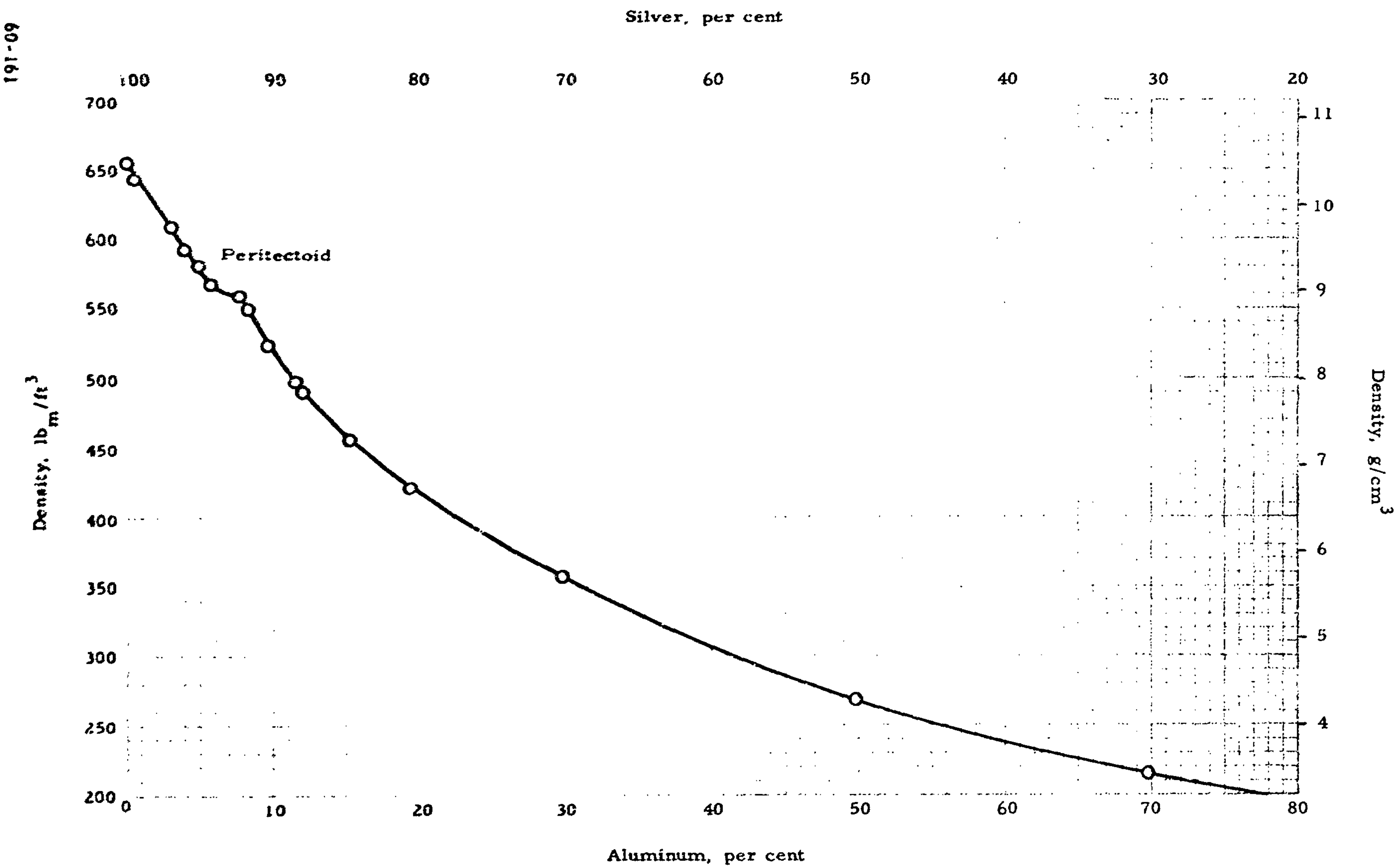


ELECTRIC RESISTIVITY -- GOLD + PLATINUM

ELECTRIC RESISTIVITY -- GOLD + PLATINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F. A.	56-46	132-1392	99.99% pure gold	Potential drop; Pt-Rh thermocouple and Cu-Const thermocouple	Vacuum melted 100°C above MP, swaged to 0.030" dia.; annealed 1 hr. at 500°C
□	Ibid.	56-46	132-1392	1.0% Pt	Same as above	Vacuum melted 100°C above MP from 99.99% pure metals, homogenized 24 hr. at 900°C, swaged to 0.030" dia.; annealed 1 hr. at 500°C
△	Ibid.	56-46	132-1392	2.00% Pt	Same as above	Same as above
◇	Ibid.	56-46	132-1392	3.1% Pt	Same as above	Same as above
▽	Ibid.	56-46	132-1392	4.0% Pt	Same as above	Same as above



DENSITY -- SILVER + ALUMINUM

DENSITY -- SILVER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Powell, H., Handel, and Evans, E. J.	43-4	Room	0 - 70% Al; 99.99% pure	Weight in air and in water	

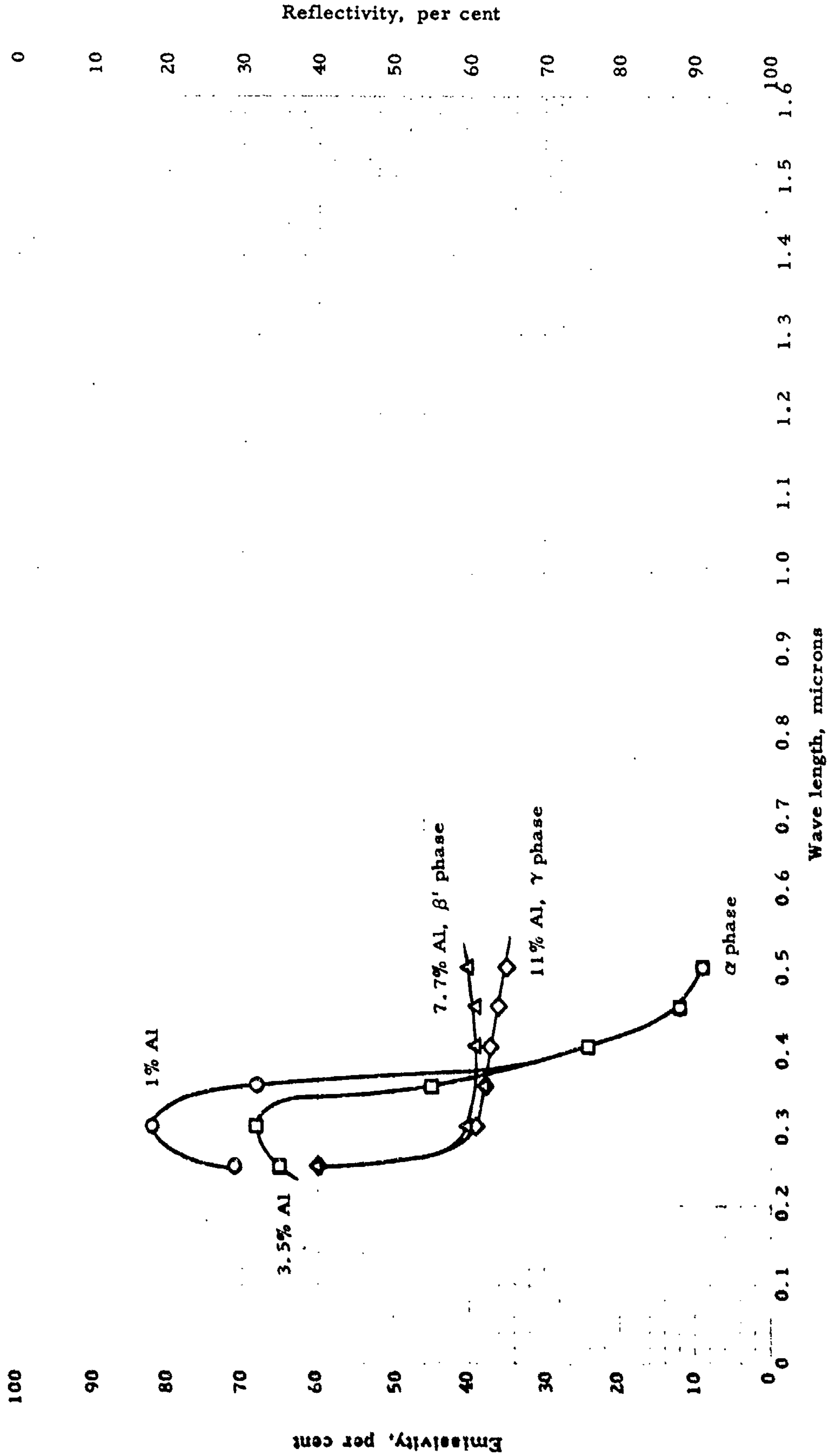
Symbol	Nominal Composition		Average Temp.		Heat of Sublimation	
	% Ag	% Al	°R	°K	Btu/lb_m	cal/g
O	100.0	0	1896	1053	1104	613
	98.0	2	1824	1013	812	451
	97.0	3	1806	1003	722	401
	66.1	33.9	1887	1048	710	394
	16.5	83.5	1505	836	3553	1863
	9.6	90.4	1455	808	3401	1884

PROPERTIES OF SILVER + ALUMINUM

PROPERTIES OF SILVER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Finkelshtein, B. N. and Yamshchikova, A. I.	54-70	1374-2040	Silver-aluminum alloy system; 100 - 9.69% Ag	ρ: not described, refers to others	Reports diffusion coefficient and its energy of activation

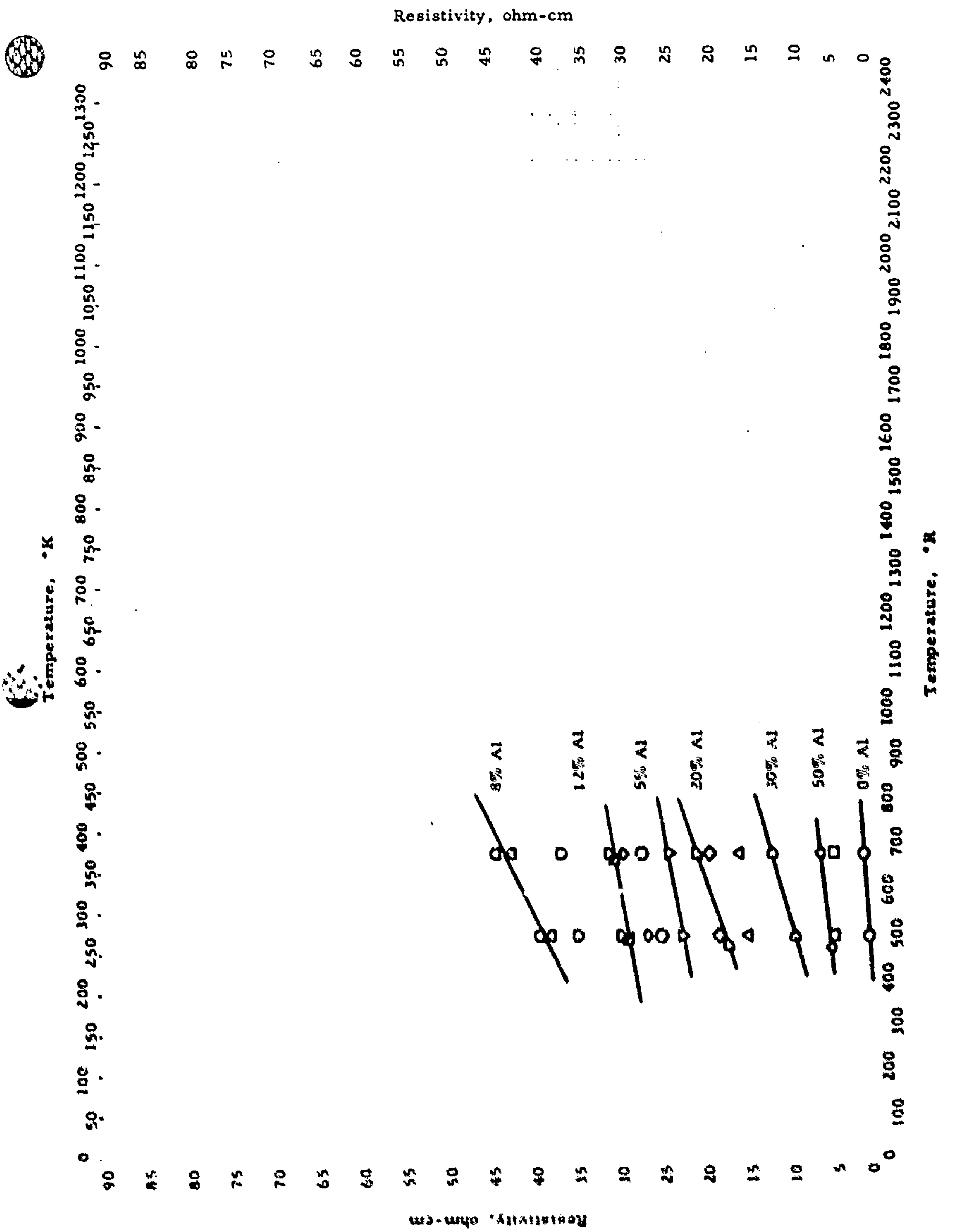


SPECTRAL EMISSIVITY -- SILVER + ALUMINUM

SPECTRAL EMISSIVITY -- SILVER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Boettcher, A.	50-28	Room	99.00% Ag; α - phase	Spectral reflectivity at 45°: intensity of direct U.V. light and that reflected at 45° compared on photographic plate	Evaporated metal layer, heat treated after deposit to insure complete alloying
□	Ibid.	50-28	Room	96.5% Ag; α - phase	Same as above	Same as above
△	Ibid.	50-28	Room	92.3% Ag; β' - phase	Same as above	Same as above
◇	Ibid.	50-28	Room	89.0% Ag; γ - phase	Same as above	Same as above

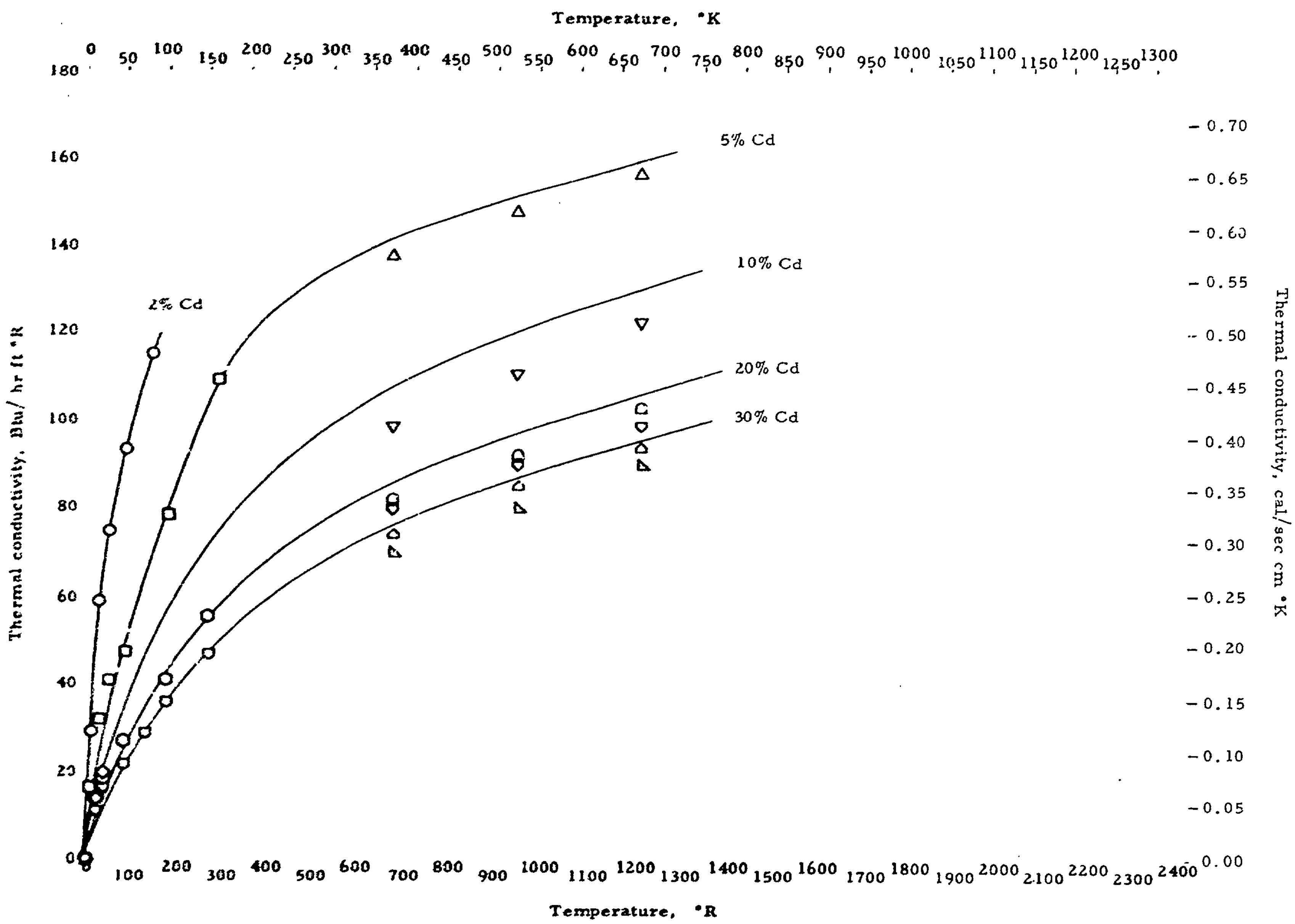


ELECTRIC RESISTIVITY -- SILVER + ALUMINUM

ELECTRIC RESISTIVITY -- SILVER + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Powell, H., Handel, and Evans, E. J.	43-4	492-672	100.00% Ag ρ = 655 lb_m/ft^3	Potential drop across knife edges. Temp. by immersion in ice bath and boiling water bath	
□	Ibid.	43-4	492-672	99.50% Ag; 0.50% Al ρ = 643 lb_m/ft^3	Same as above	
△	Ibid.	43-4	492-672	97.00% Ag; 3.00% Al ρ = 608 lb_m/ft^3	Same as above	
◇	Ibid.	43-4	492-672	96.11% Ag; 3.89% Al ρ = 592 lb_m/ft^3	Same as above	
▽	Ibid.	43-4	492-672	95.08% Ag; 4.92% Al ρ = 580 lb_m/ft^3	Same as above	
⬡	Ibid.	43-4	492-672	94.29% Ag; 5.71% Al ρ = 567 lb_m/ft^3	Same as above	
◻	Ibid.	43-4	492-672	92.30% Ag; 7.70% Al ρ = 558 lb_m/ft^3	Same as above	
△	Ibid.	43-4	492-672	91.75% Ag; 8.25% Al ρ = 549 lb_m/ft^3	Same as above	
◻	Ibid.	43-4	492-672	90.40% Ag; 9.60% Al ρ = 524 lb_m/ft^3	Same as above	
▽	Ibid.	43-4	492-672	88.50% Ag; 11.50% Al ρ = 497 lb_m/ft^3	Same as above	
◺	Ibid.	43-4	492-672	87.96% Ag; 12.04% Al ρ = 490 lb_m/ft^3	Same as above	
◇	Ibid.	43-4	492-672	84.74% Ag; 15.26% Al ρ = 455 lb_m/ft^3	Same as above	
▽	Ibid.	43-4	492-672	80.60% Ag; 19.40% Al ρ = 421 lb_m/ft^3	Same as above	
▷	Ibid.	43-4	492-672	70.23% Ag; 29.77% Al ρ = 357 lb_m/ft^3	Same as above	
◇	Ibid	43-4	492-672	50.19% Ag; 49.81% Al ρ = 268 lb_m/ft^3	Same as above	

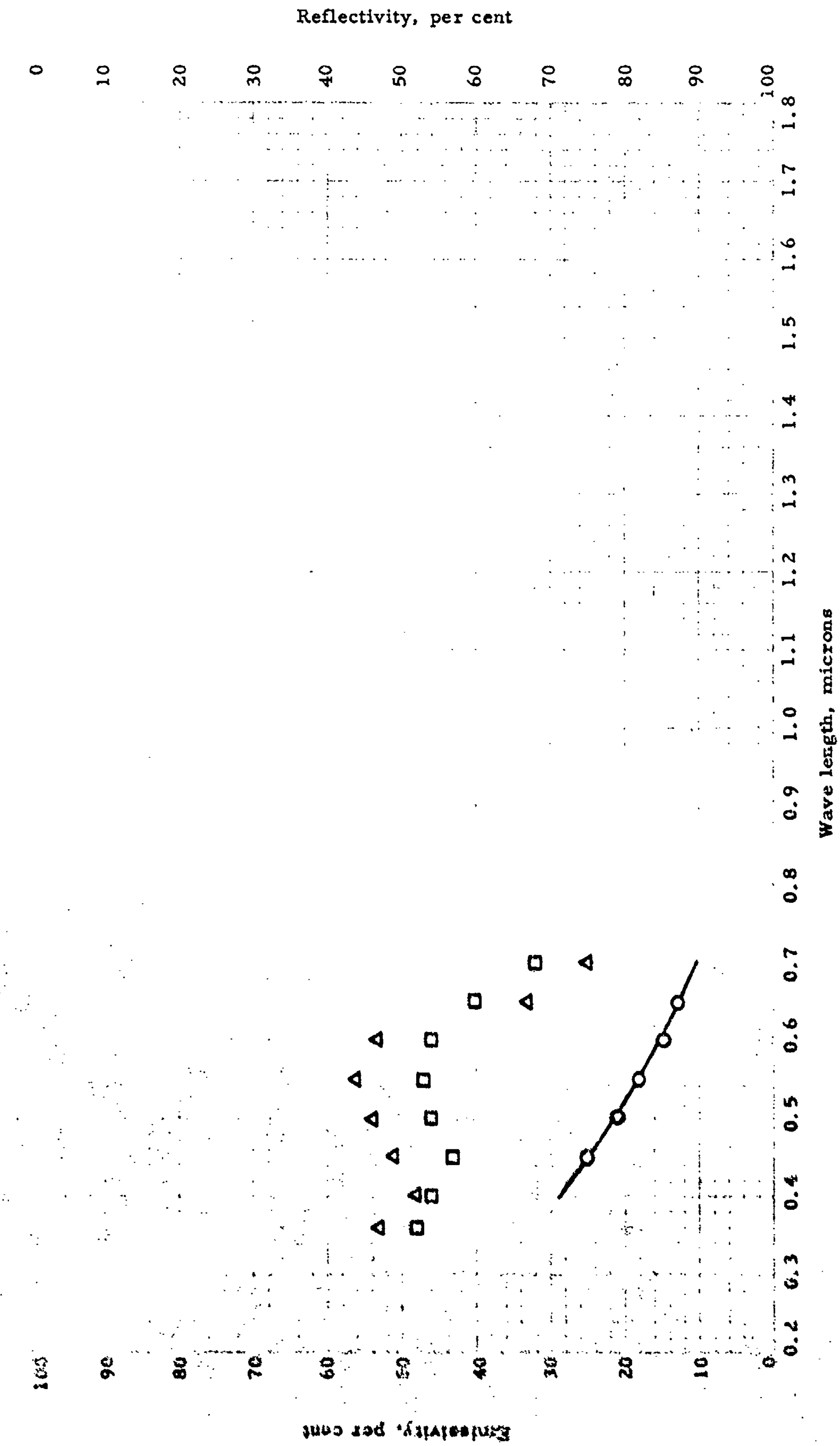


THERMAL CONDUCTIVITY -- SILVER + CADMIUM

THERMAL CONDUCTIVITY -- SILVER + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W. R. G., Klemens, P. G. et al.	56-30	3-288	2% Cd	Axial heat flow in rod; guarded heat source	Annealed at 530°C
□	Ibid.	56-30	3-288	5% Cd	Same as above	Same as above
△	Deem, H. W. and Nelson, H. R.	51-31	672-1212	5.4% Cd	Comparative; rods	
◇	Kemp, W. R. G., Klemens, P. G. et al.	56-30	3-288	10% Cd	Axial heat flow in rod; guarded heat source	Annealed at 500 and 610°C
▽	Deem, H. W. and Nelson, H. R.	51-31	672-1212	12.9% Cd	Comparative; rods	
○	Kemp, W. R. G., Klemens, P. G. et al.	56-30	3-288	20% Cd	Axial heat flow in rod; guarded heat source	Annealed at 500°C
○	Deem, H. W. and Nelson, H. R.	51-31	672-1212	22.0% Cd	Comparative; rods	Cross-section reduced 67% by rolling
○	Ibid.	51-31	672-1212	24.5% Cd	Same as above	Same as above
○	Kemp, W. R. G., Klemens, P. G. et al.	56-30	3-288	30% Cd	Axial heat flow in rod; guarded heat source	Annealed at 500°C
○	Deem, H. W. and Nelson, H. R.	51-31	672-1212	31.8% Cd	Comparative; rods	Cross-section reduced 67% by rolling
△	Ibid.	51-31	672-1212	35.6% Cd	Same as above	

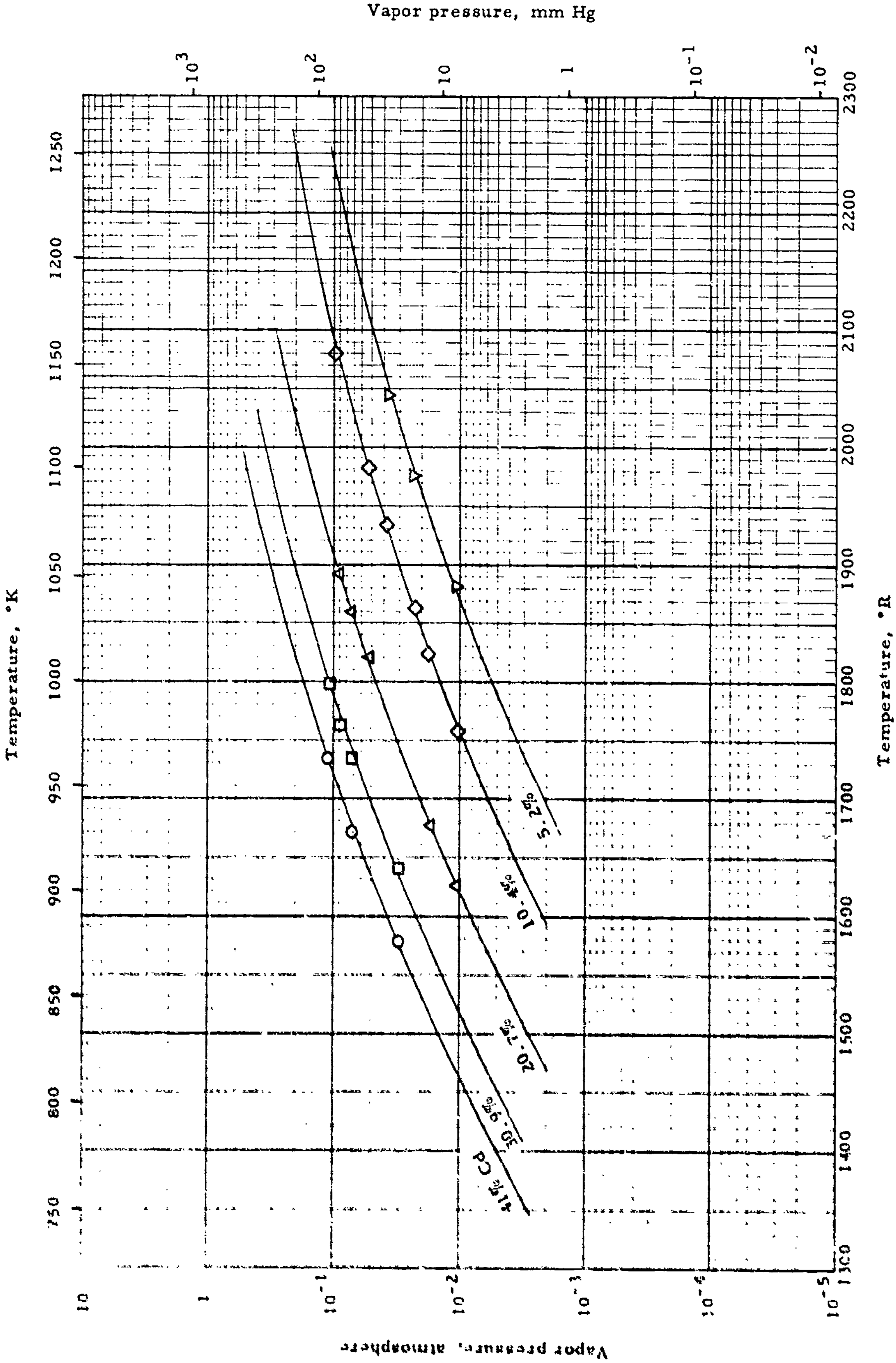


SPECTRAL EMISSIVITY -- SILVER + CADMIUM + X

SPECTRAL EMISSIVITY -- SILVER + CADMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Engel, M.	39-4	Room	91.99% Ag; 6.78% Cd; 1.33% Al	Spectral reflectivity at 45°: comparative: compared with calibrated Cr and Rh mirrors	
□	Muldawer, L.	57-96	542-874	Not given	Spectral reflectivity: Beckman spectrophotometer	At 874°R
△	Ibid.	57-96	542-874	Same as above	Same as above	At 542°R

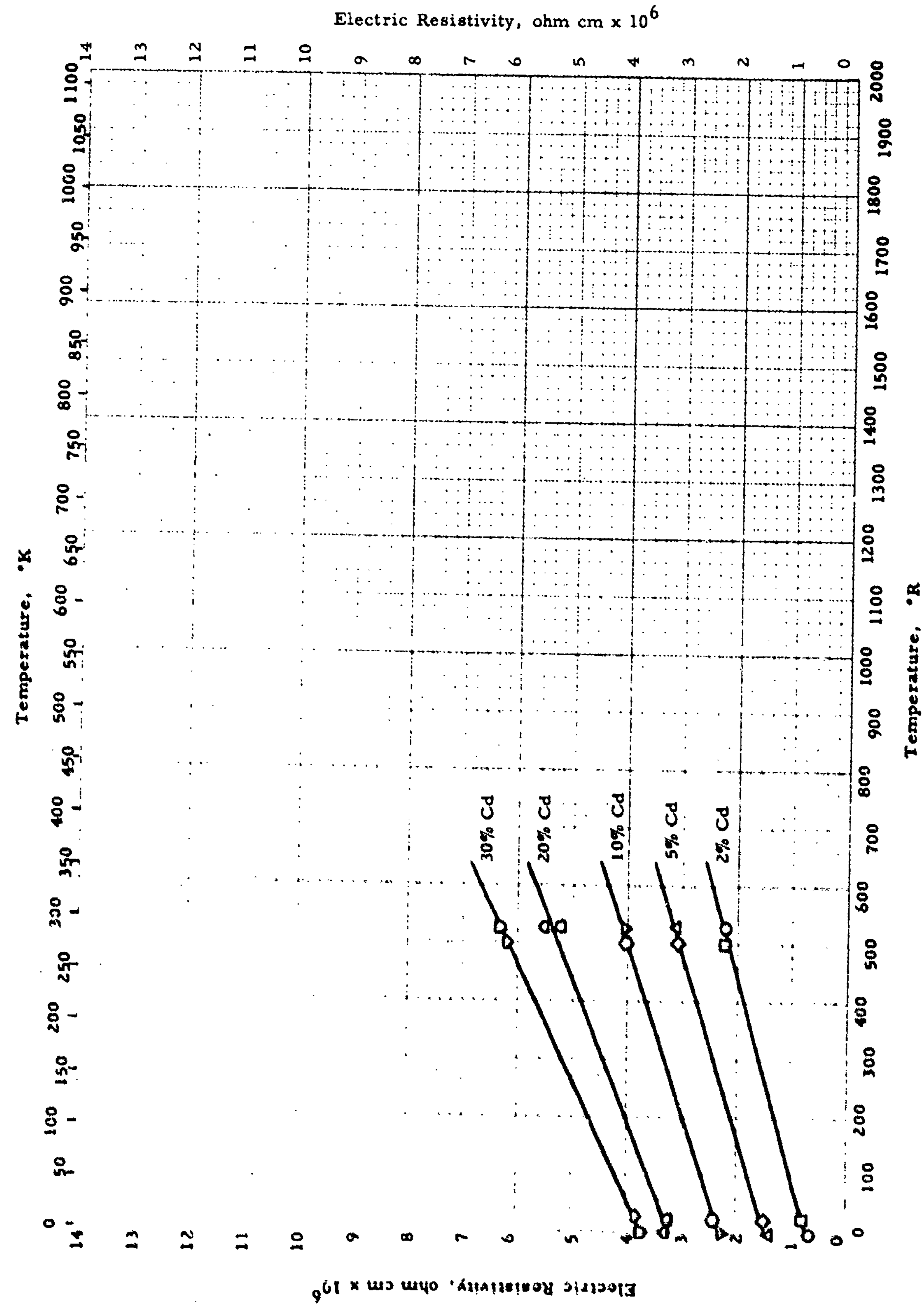


VAPOR PRESSURE -- SILVER + CADMIUM

VAPOR PRESSURE -- SILVER + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Herasymenko, P.	55-65	1572-1734	41% Cd; $\alpha + \beta$ phase	Initially pure Ag wire soaked to equilibrium in a constant pressure of Cd vapor. Final composition of wire determined	Data are pressure of Cd over the alloy
□	Ibid.	55-65	1640-1797	30.9% Cd; α-phase	Same as above	Same as above
△	Ibid.	55-65	1624-1892	20.7% Cd; α-phase	Same as above	Same as above
◇	Ibid.	55-65	1757-2080	10.4% Cd; α-phase	Same as above	Same as above
▽	Ibid.	55-65	1882-2045	5.2% Cd; α-phase	Same as above	Same as above

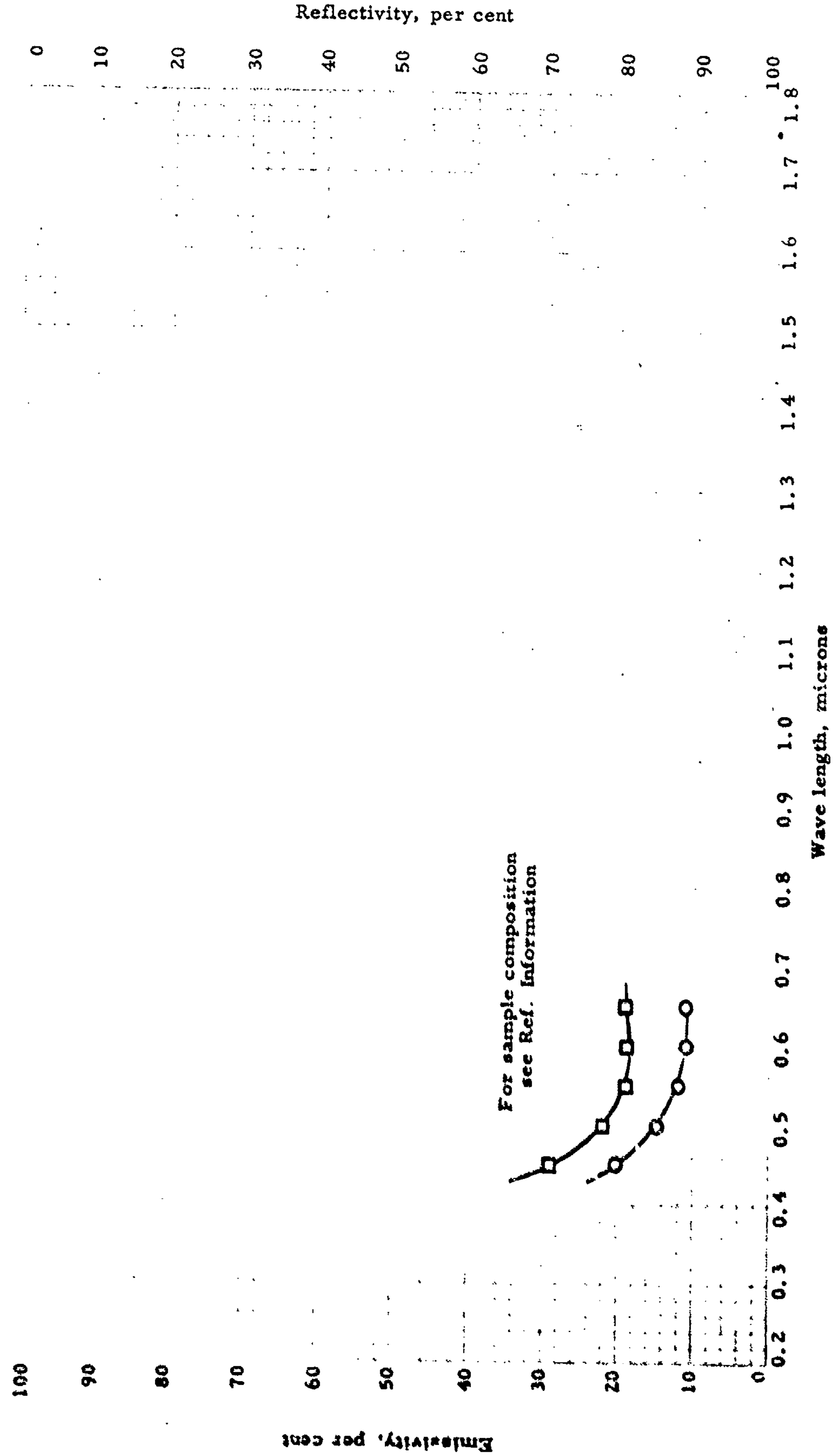


ELECTRIC RESISTIVITY -- SILVER + CADMIUM

ELECTRIC RESISTIVITY -- SILVER + CADMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W. R. G., Klemens, P. G. et al.	56-30	0-528	1.96% Cd	Not described here, refers to others	Wire, annealed at 500°C
□	Ibid	56-30	0-528	Same as above	Same as above	Rod, annealed at 530°C
△	Ibid	56-30	0-528	4.91% Cd	Same as above	Wire, annealed at 530°C
◇	Ibid	56-30	0-528	Same as above	Same as above	Rod, annealed at 530°C
▽	Ibid.	56-30	0-528	9.51% Cd	Same as above	Wire, annealed at 500°C
○	Ibid	56-30	0-528	Same as above	Same as above	Rod, annealed at 610°C
□	Ibid	56-30	0-528	19.21% Cd	Same as above	Wire, annealed at 500°C
△	Ibid	56-30	0-528	Same as above	Same as above	Rod, recast
◇	Ibid	56-30	0-528	29.97% Cd	Same as above	Wire, annealed at 500°C
▽	Ibid	56-30	0-528	Same as above	Same as above	Rod, annealed at 500°C

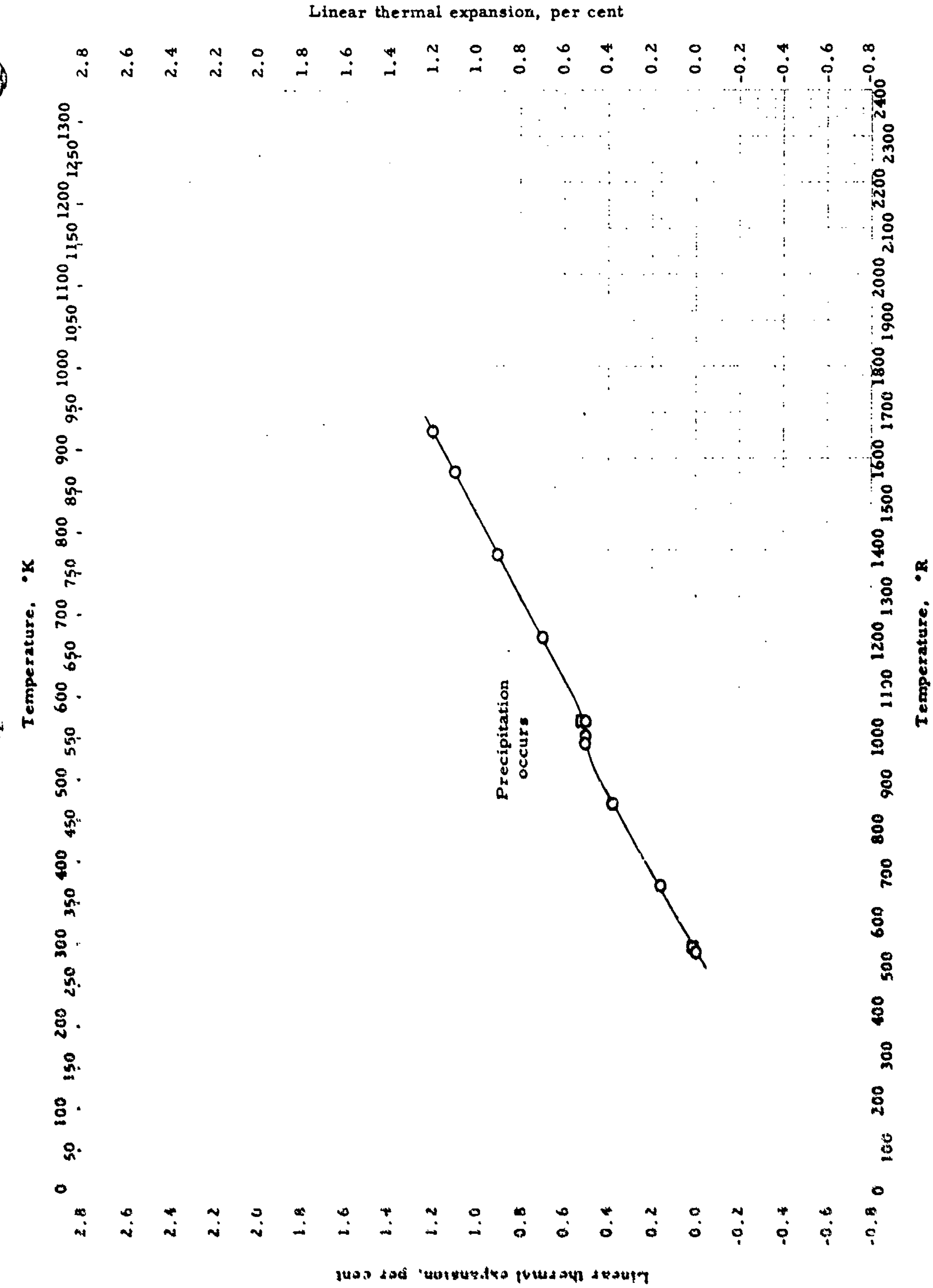


SPECTRAL EMISSIVITY -- SILVER + COPPER + X

SPECTRAL EMISSIVITY -- SILVER + COPPER + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Engel, M.	39-4	Room	92.77% Ag; 5.86% Cu; 1.37% Al	Spectral reflectivity at 45°: comparative: sample compared with calibrated Cr and Rh mirrors	Castings cold rolled with intermediate annealing. Freshly polished
□	Ibid.	39-4	Room	92.69% Ag; 6.51% Cu; 0.80% Be	Same as above	Same as above

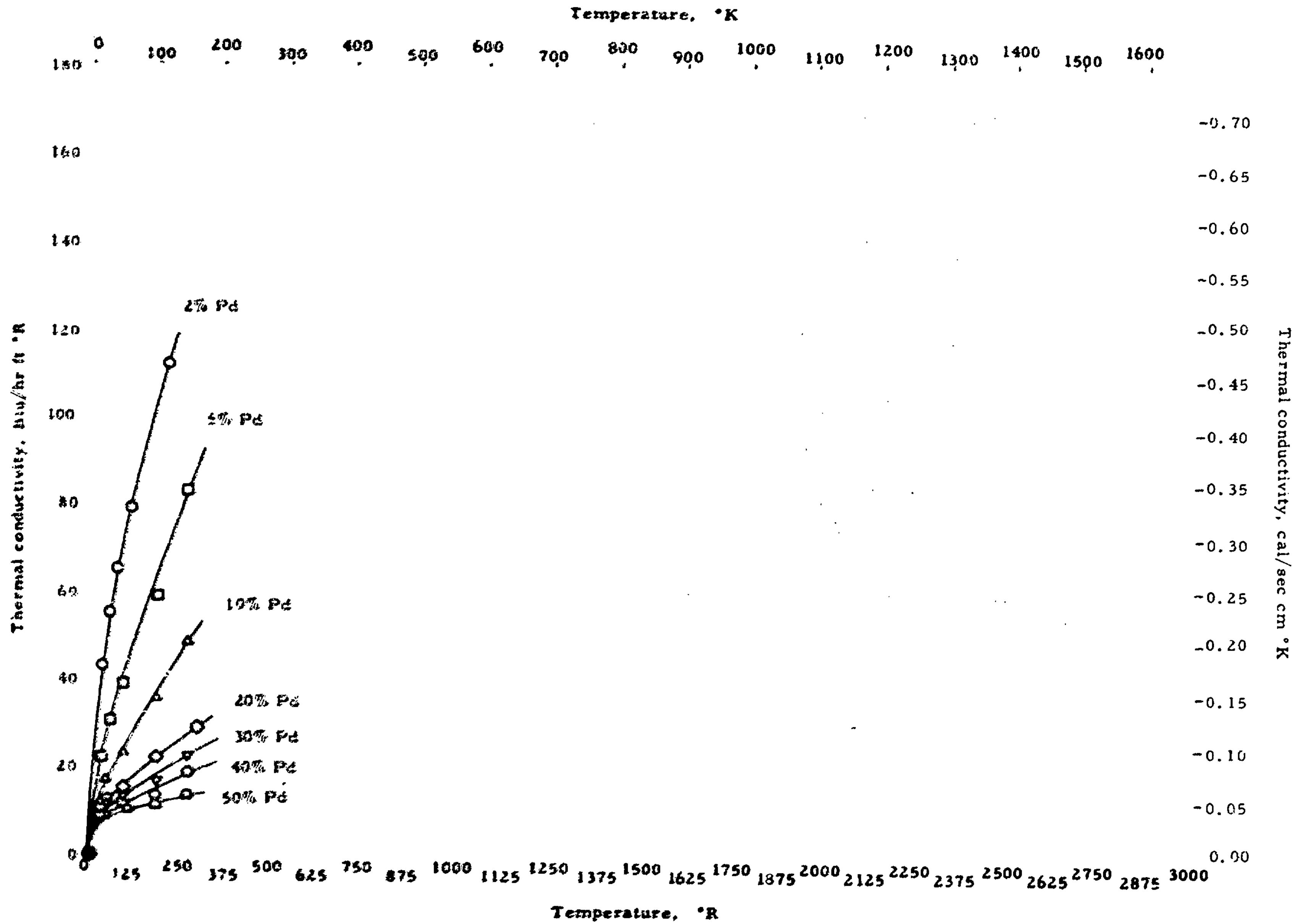


LINEAR THERMAL EXPANSION -- SILVER + COPPER

LINEAR THERMAL EXPANSION -- SILVER + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Wolff, K.	49-12	528-1662	93% Ag; 7% Cu	Leitz comparative dilatometer, Bollenrath head (Ag standard)	"Homogenized"; tested at 1.6°C/min.
□	Waldhauser, L.	55-117	528-1032	6 samples: (a) 78.5% Ag; 21.4% Cu; 0.027% As; 0.010% P (b) 76.7% Ag; 23.2% Cu; 0.027% As; 0.012%P (c) 74.3% Ag; 25.4% Cu; 0.017% As; 0.010% P (d) 71.3% Ag; 28.6% Cu; 0.021% As; 0.012% P (e) 69.2% Ag; 30.2% Cu; 0.027% As; 0.012% P (f) 59.5% Ag; 40.3% Cu; 0.021% As; 0.012% P	Quartz tube dilatometer, Leitz-Bollenrath. Temp. by thermocouple	Cast. Values of the 6 samples are within ± 5% of plotted point

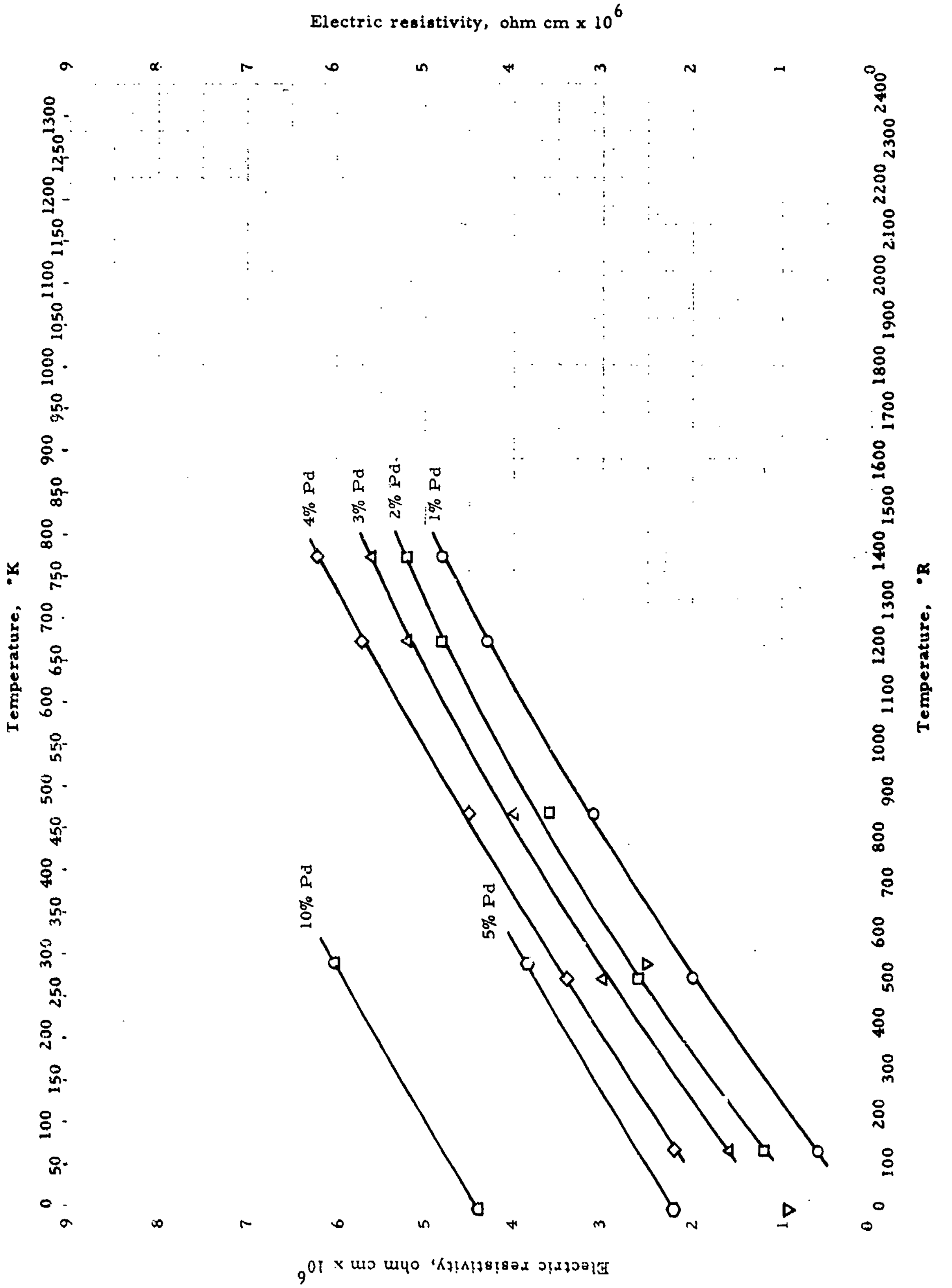


THERMAL CONDUCTIVITY -- SILVER + PALLADIUM

THERMAL CONDUCTIVITY -- SILVER + PALLADIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W. R. G., Klemens, P. G. et al.	56-30	3-288	2% Pd	Axial heat flow in rod heated on one end, guarded heat source and sample	Annealed at 610°C
□	Ibid.	56-30	3-288	5% Pd	Same as above	Same as above
△	Ibid.	56-30	3-288	10% Pd	Same as above	Annealed at 650°C
◇	Ibid.	56-30	3-288	20% Pd	Same as above	Annealed at 650°C and 800 °C
▽	Ibid.	56-30	3-288	30% Pd	Same as above	Annealed at 800°C
⬡	Ibid.	56-30	3-288	40% Pd	Same as above	Annealed at 880°C
⌂	Ibid.	56-30	3-288	50% Pd	Same as above	Same as above



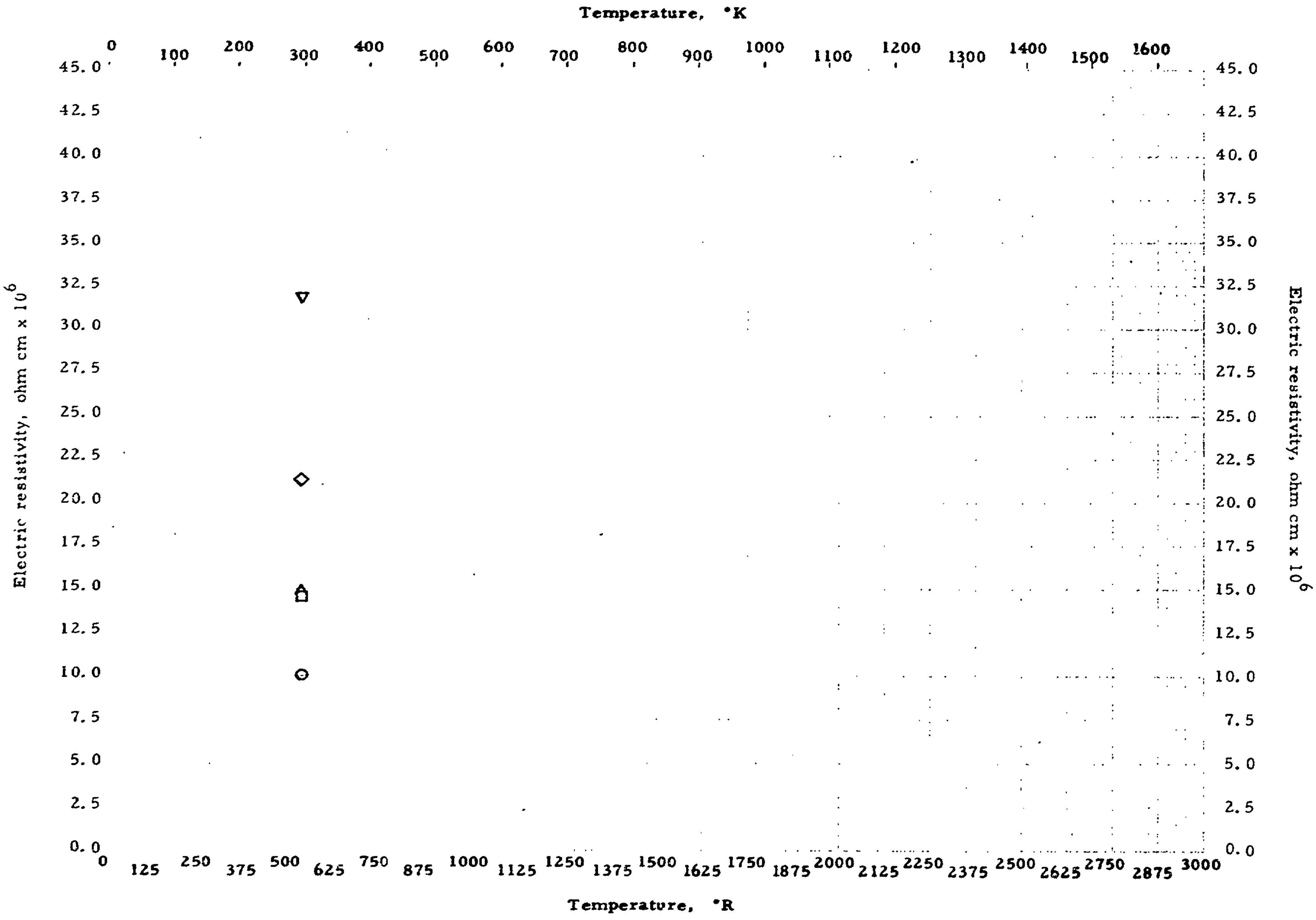
ELECTRIC RESISTIVITY -- SILVER + PALLADIUM

(0 - 10% Pd)

ELECTRIC RESISTIVITY -- SILVER + PALLADIUM
(0 - 10% Pd)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F.A.	56-46	132-1392	1.1% Pd	Potential drop inside a heavy copper shield, Pt-Rh thermocouple	Vac. melted from 99.99% pure metals 100°C above MP, homogenized 24 hr. at 900°C, swaged to 0.030 inch dia., annealed 1 hr at 500°C
□	Ibid.	56-46	132-1392	2.0% Pd	Same as above	Same as above
△	Ibid.	56-46	132-1392	3.0% Pd	Same as above	Same as above
◇	Ibid.	56-46	132-1392	4.1% Pd	Same as above	Same as above
▽	Kemp, W.R.G., Klemens, P.G. et al.	56-30	528	2.08% Pd	Not described here, refers to others	Plotted data avg. of two samples. (within ± 0.5%). Sample A, wire annealed at 610°C. Sample B, rod annealed at 610°C
⬡	Ibid.	56-30	528	5.06% Pd	Same as above	Same as above
⌂	Ibid.	56-30	528	9.9% Pd	Same as above	Same as above, except annealings at 650°C

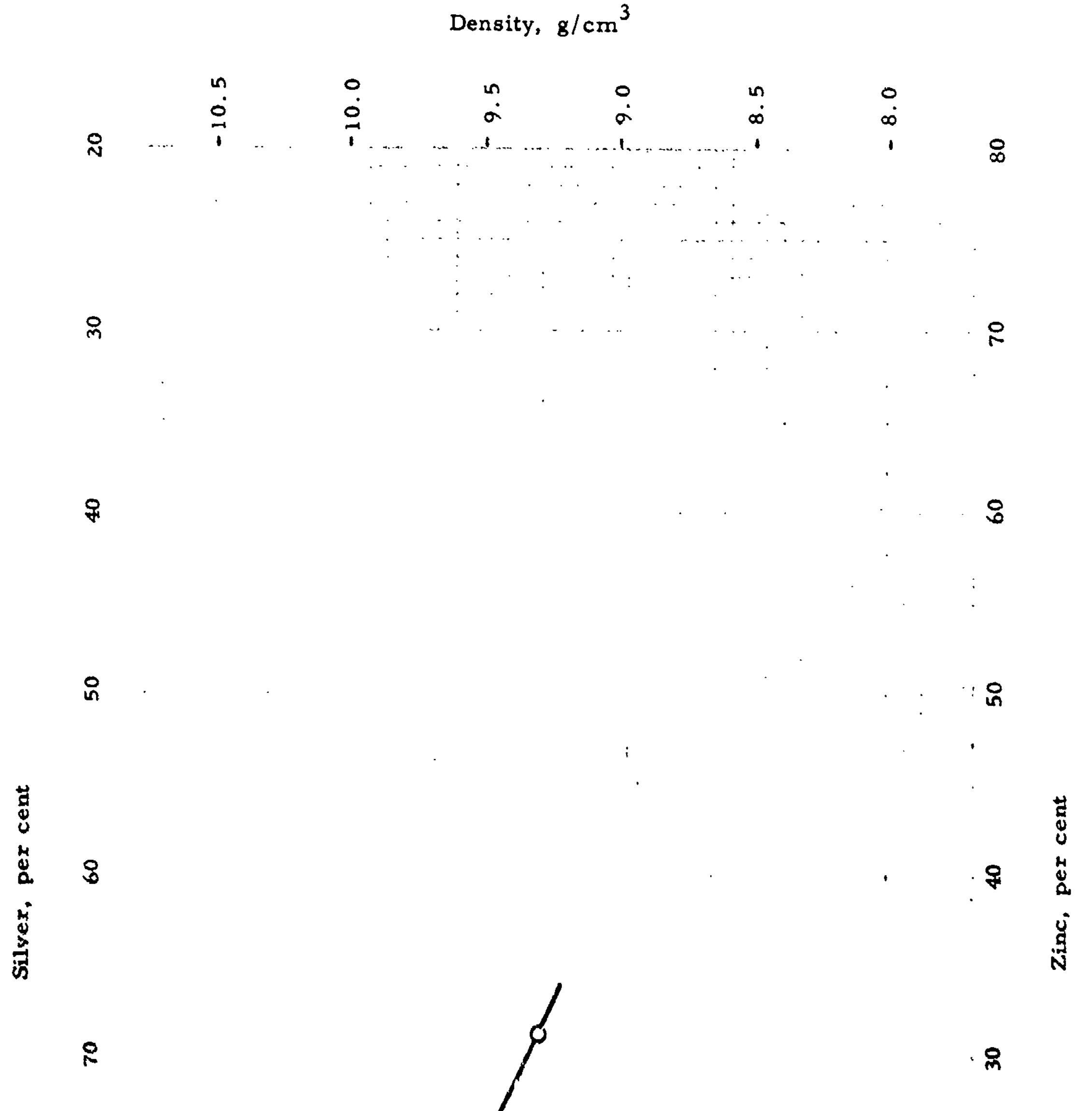


ELECTRIC RESISTIVITY -- SILVER + PALLADIUM
(10 - 50% Pd)

ELECTRIC RESISTIVITY -- SILVER + PALLADIUM
(10 - 50% Pd)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W.R.G., Klemens, P.G. et al.	56-30	528	20.08% Pd	Not described here, refers to others	Wire, annealed at 650°C
□	Ibid.	56-30	528	29.62% Pd	Same as above	Same as above
△	Ibid.	56-30	528	Same as above	Same as above	Rod, annealed at 800°C
◇	Ibid.	56-30	528	40% Pd	Same as above	Plotted data avg. of two samples within ± 2%. Sample a) wire annealed at 880°C and 500°C. Sample b) rod annealed at 880°C
▽	Ibid.	56-30	528	50% Pd	Same as above	Same as above



DENSITY -- SILVER + ZINC

DENSITY -- SILVER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Stockdale, D.	40-12	Room	5 - 31% Zn; negligible impurities	Weight in air and in CCl_4	

PROPERTIES OF SILVER + ZINC

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.	*	*
Melting Point 50% Ag . .	1690 °R	940 °K
Heat of Fusion 50% Ag .	41 Btu/lb_m	23 cal/g
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* See graph of ρ versus Composition, Sheet 60-168.

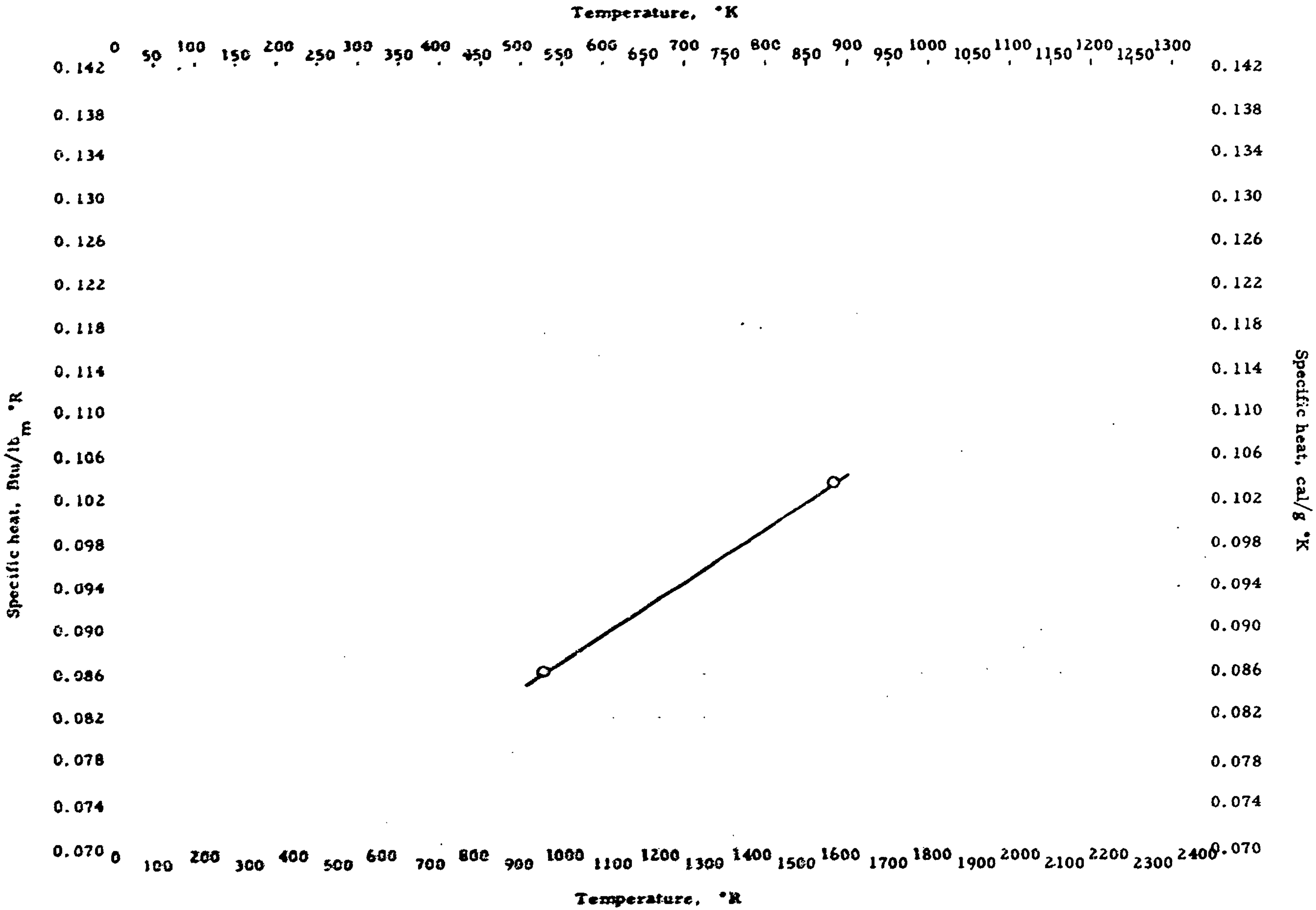
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	1687	937
Heat of Fusion:		Btu/lb_m	cal/g
	O	41.02 ± 1.76	22.79 ± 0.98
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF SILVER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubachewski, O.	43-13	1687	49.5% Zn	MP: break in time-temp. curve	γ-phase
			1687		ΔH_f: enthalpy difference of solid and liquid meas. in calorimeter	Auth. est. accuracy $\pm$ 2.3% in ΔH_f

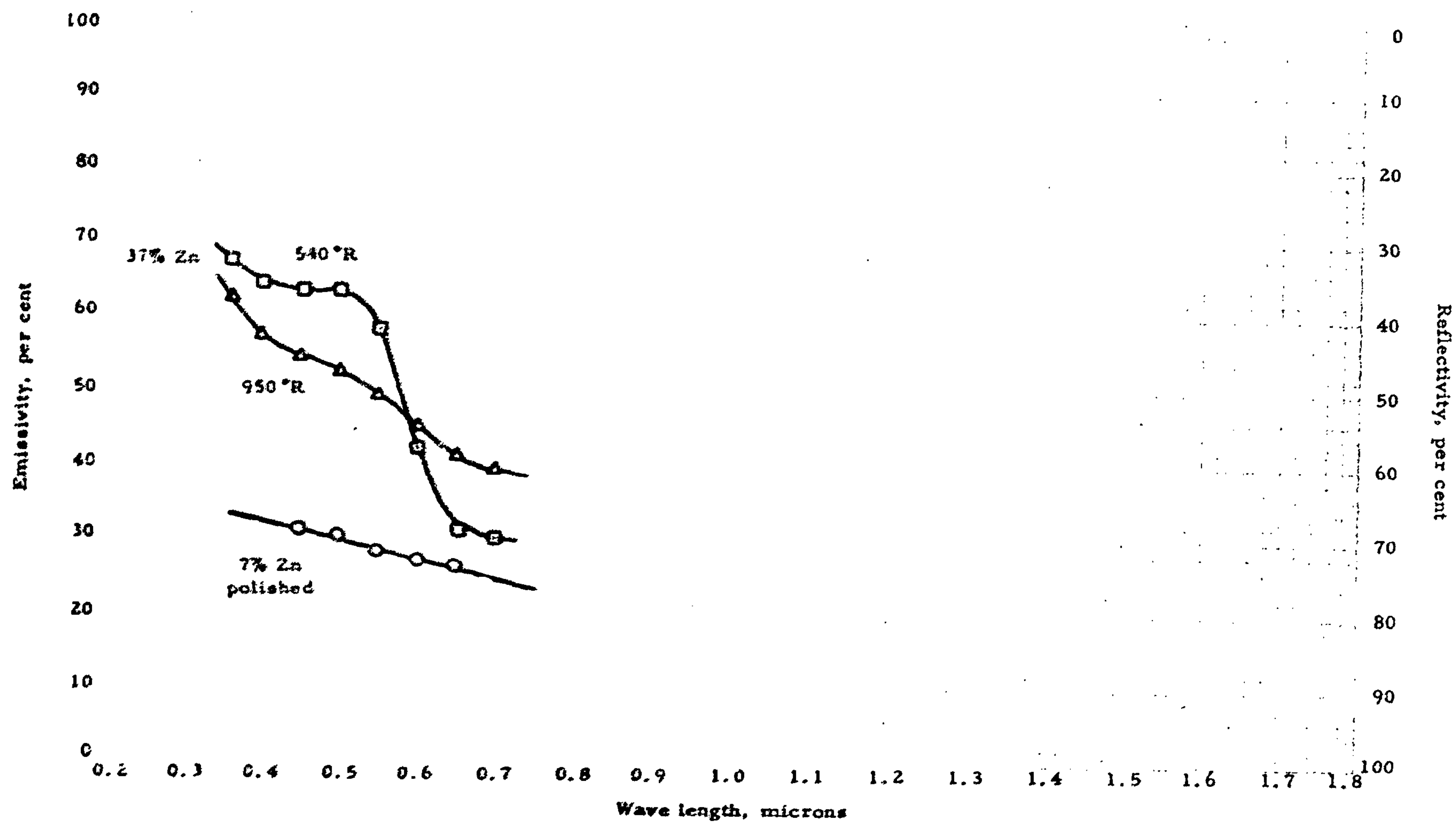


SPECIFIC HEAT -- SILVER + ZINC

SPECIFIC HEAT -- SILVER + ZINC

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kubaschewski, O.	43-13	952-1585	49.5% Zn γ phase	Enthalpy meas. with calorimeter	Auth. est. accuracy ± 1%. Auth. reports mean c_p. Instantaneous c_p computed by ARF as least square fit to enthalpy data

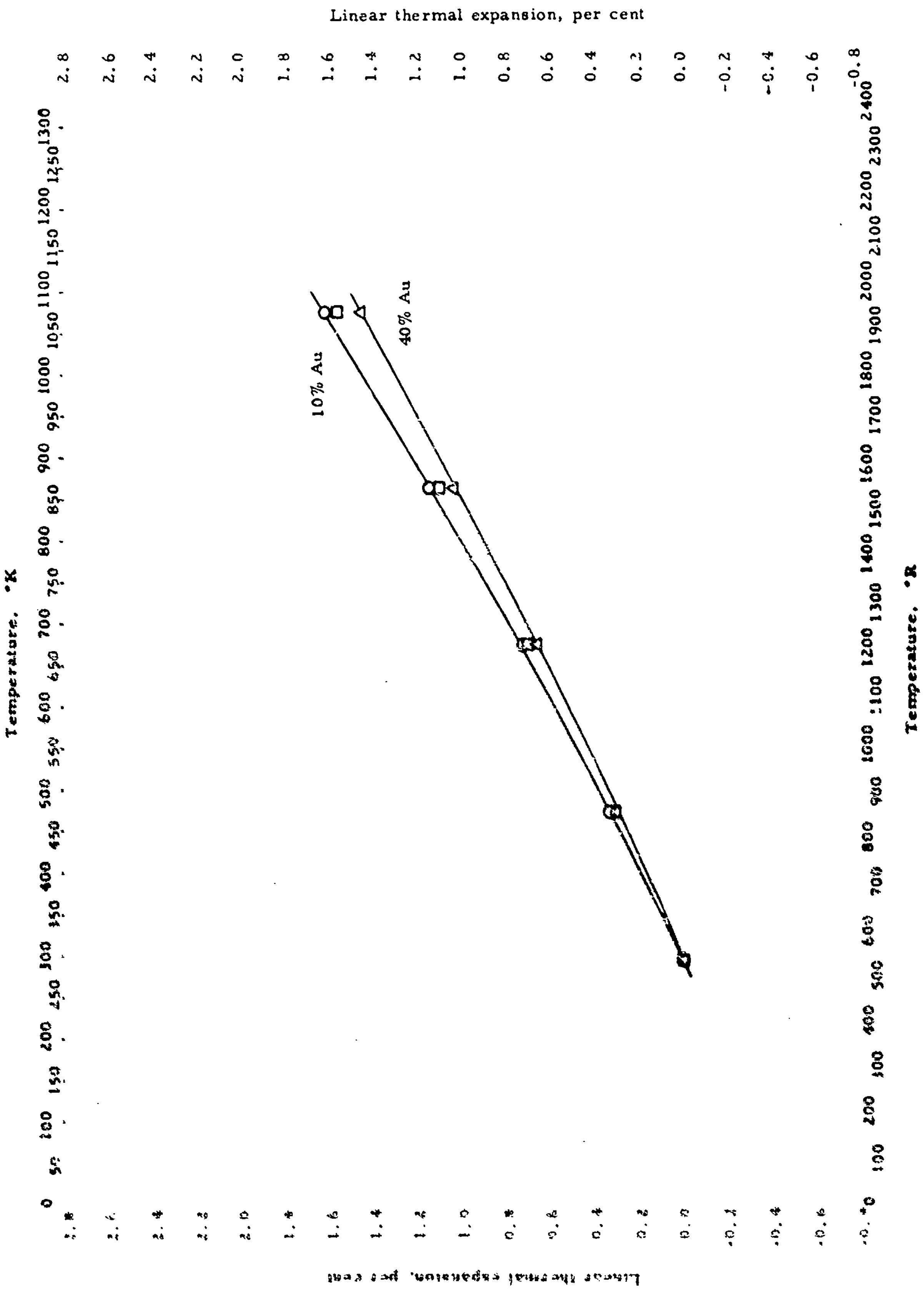


SPECTRAL EMISSIVITY -- SILVER + ZINC + X

SPECTRAL EMISSIVITY -- SILVER + ZINC + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Raub, E. and Engel, M.	39-4	Room	92.57% Ag; 6.98% Zn; 0.45% Be	Spectral reflectivity at 45°: comparative: sample compared with calibrated Cr and Rh mirrors	Cold rolled castings with intermediate annealing. Freshly polished
□	Maclawer, L.	57-96	540	55.6% Ag; 36.6% Zn; 7.7% Au	Spectral reflectivity at 18° Beckman spectrophotometer	Author believes data low
△	Ibid.	57-96	950	Same as above	Same as above	Same as above

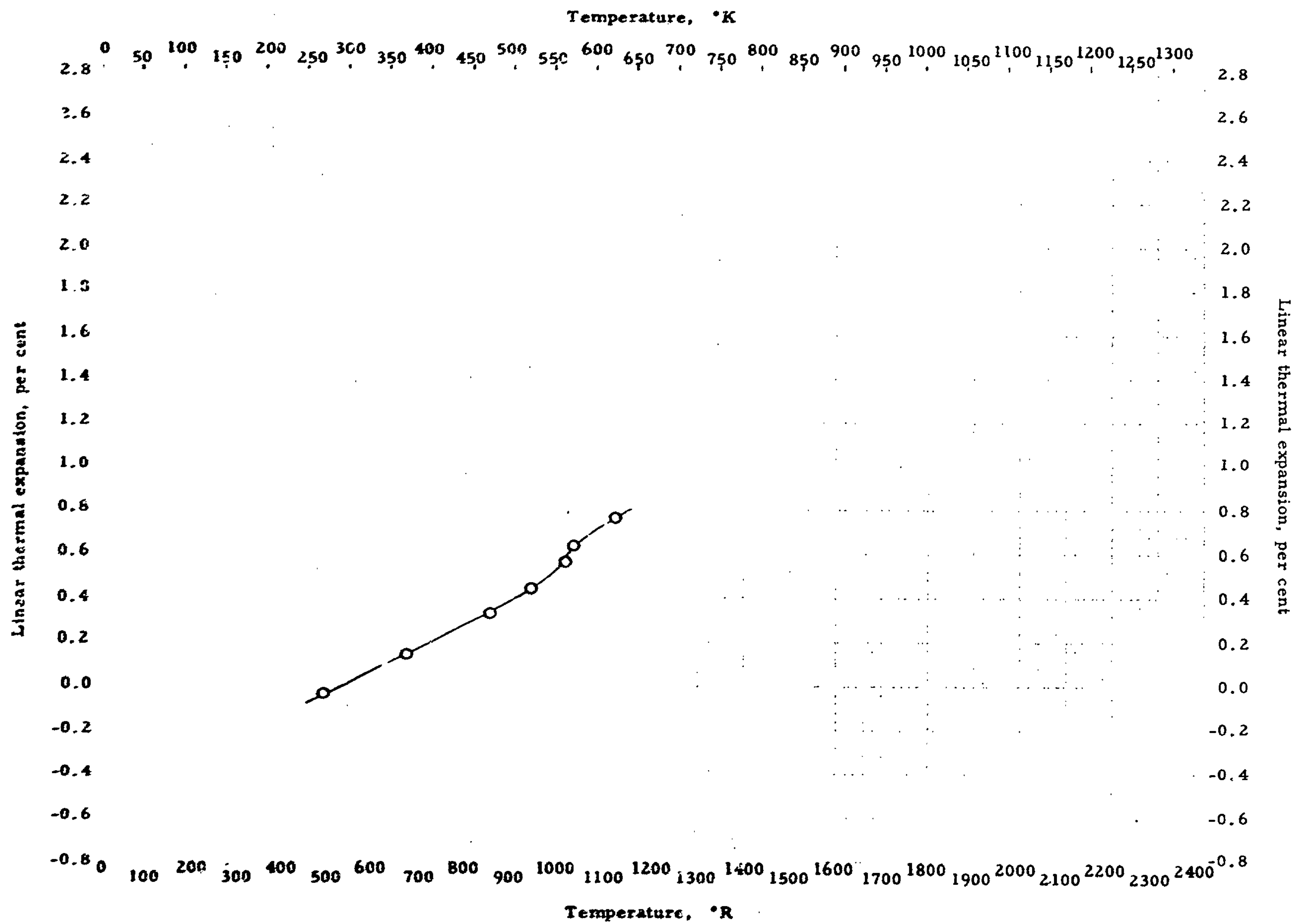


LINEAR THERMAL EXPANSION -- SILVER + GOLD

LINEAR THERMAL EXPANSION -- SILVER + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gebhardt, E., and Dorner, S.	51-41	528-1932	90% Ag, 10% Au	Dilatometer	Homogenized
□	Ibid.	51-41	528-1932	80% Ag; 20% Au	Same as above	Same as above
△	Ibid.	51-41	528-1932	60% Ag; 40% Au	Same as above	Same as above

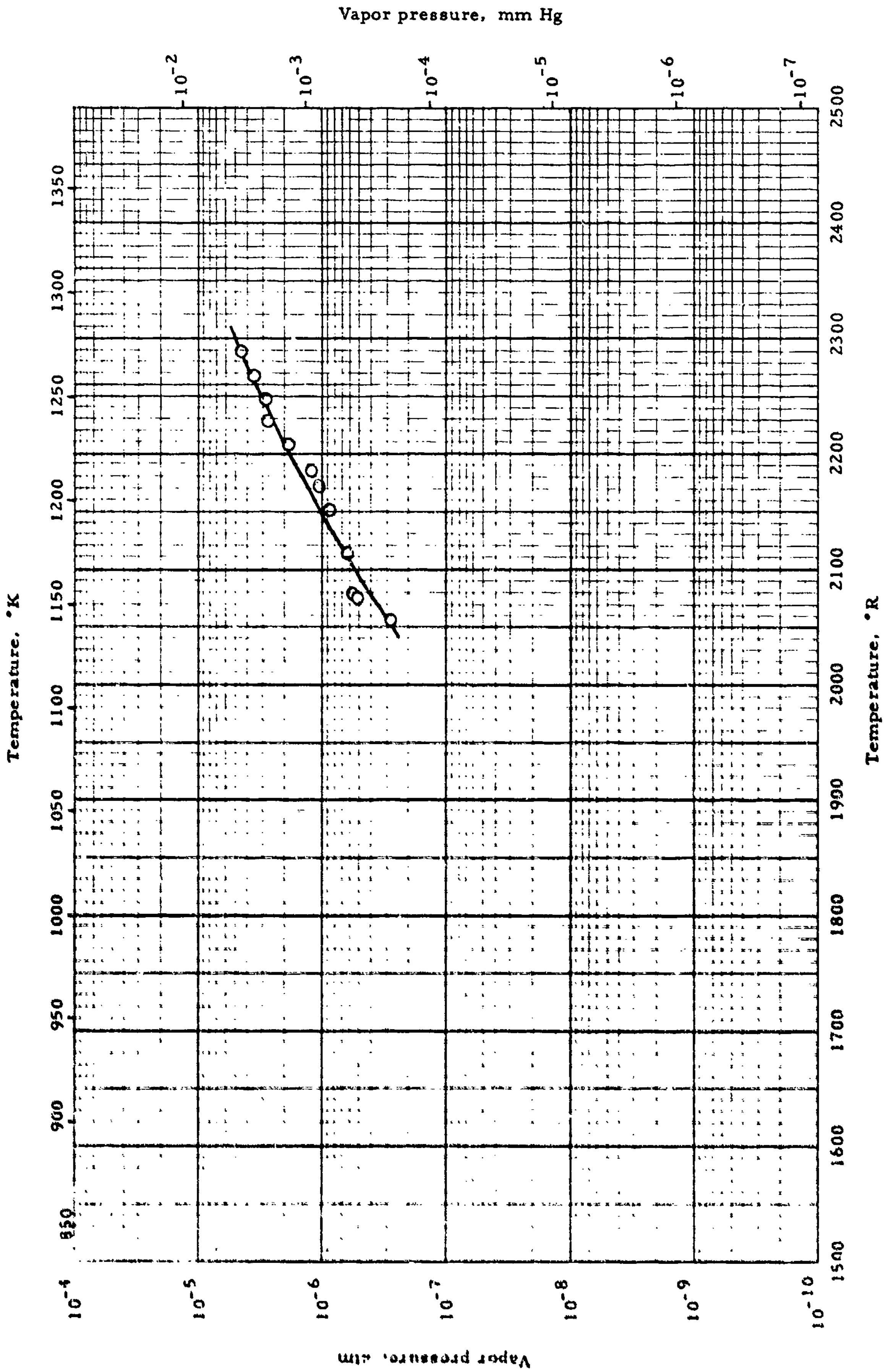


LINEAR THERMAL EXPANSION -- SILVER + LEAD

LINEAR THERMAL EXPANSION -- SILVER + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Raub, E., and Wolff, K.	49-12	492-1122	95% Ag; 5 % Pb	Leitz comparative dilatometer, Bollenrath head (Ag standard)	"Homogenized"; tested at 0.9°C/min.

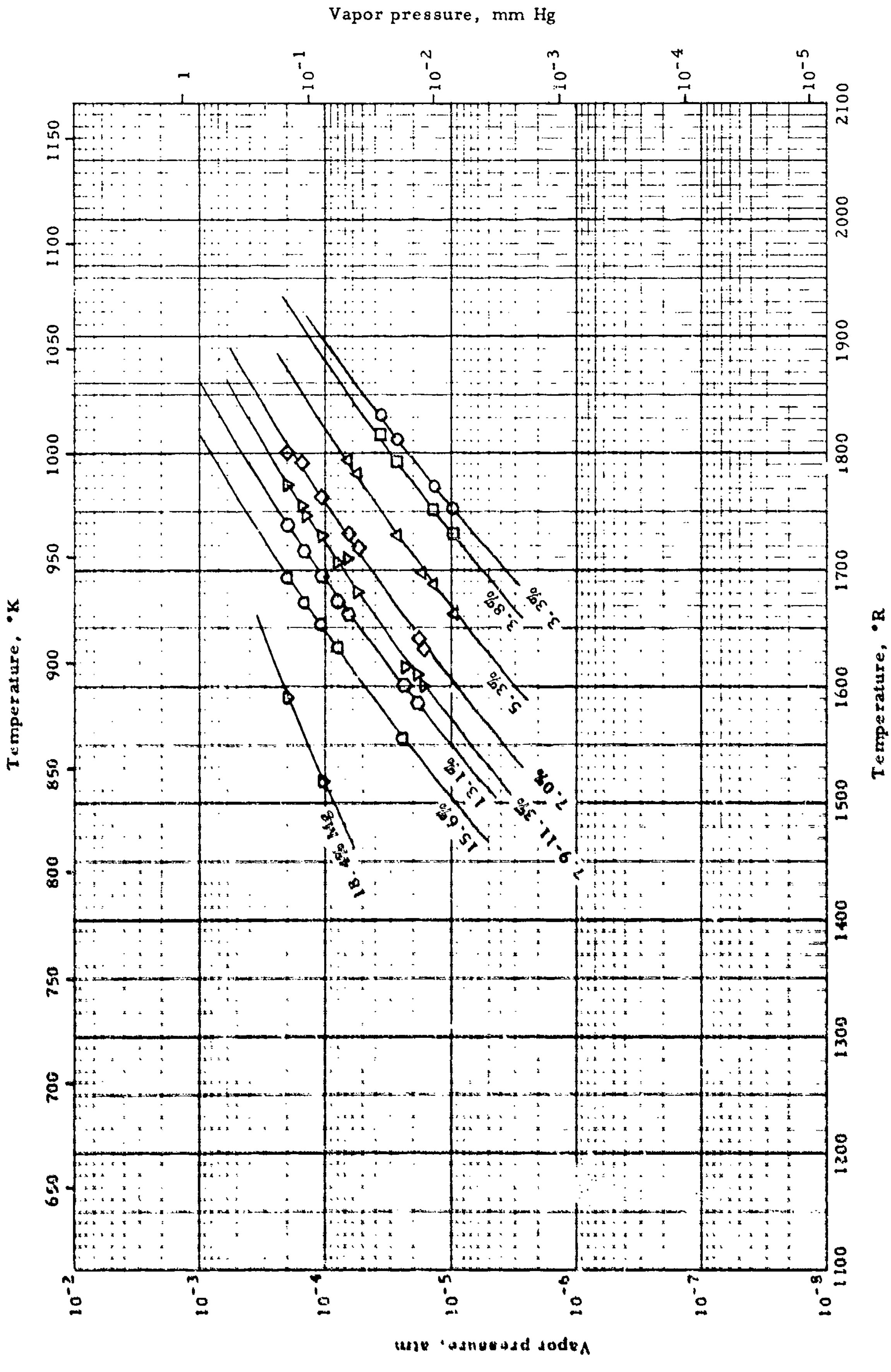


VAPOR PRESSURE -- SILVER + GOLD

VAPOR PRESSURE -- SILVER + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	McCabe, C. L., Schadel Jr. H. M. and Birchenall, C. E.	53-131	2054-2288	65.3% Ag; 34.7% Au	Knudsen effusion cell with radioactive counting	

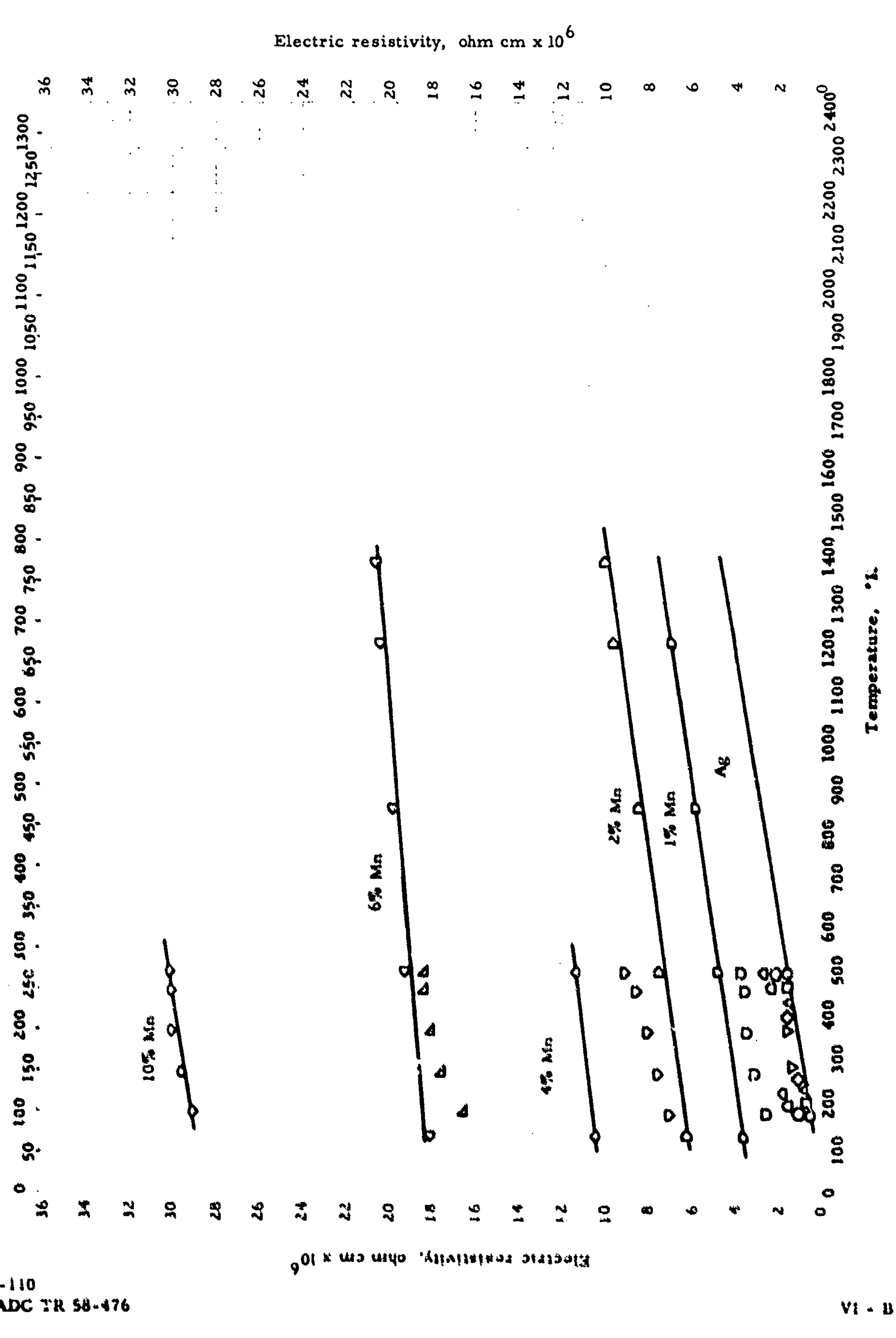


VAPOR PRESSURE -- SILVER + MAGNESIUM

VAPOR PRESSURE - - SILVER + MAGNESIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Herasymenko, P.	57-73	1518-1842	1.28% Mg, α phase	Initially pure Ag wire soaked to equilibrium in a constant pressure of Mg vapor; final composition of wire determined	Data are pressure of Mg vapor over the alloy
□	Ibid.	57-73	1518-1842	3.83% Mg, α phase	Same as above	Same as above
△	Ibid.	57-73	1518-1842	5.34% Mg, α phase	Same as above	Same as above
◇	Ibid.	57-73	1518-1842	6.99% Mg, α phase	Same as above	Same as above
▽	Ibid.	57-73	1518-1842	7.91-11.26% Mg, α + β phase (data constant over this compositional range)	Same as above	Same as above
○	Ibid.	57-73	1518-1842	13.07% Mg, β phase	Same as above	Same as above
□	Ibid.	57-73	1518-1842	15.58% Mg, β phase	Same as above	Same as above
▽	Ibid.	57-73	1518-1842	18.40% Mg, β phase	Same as above	Same as above

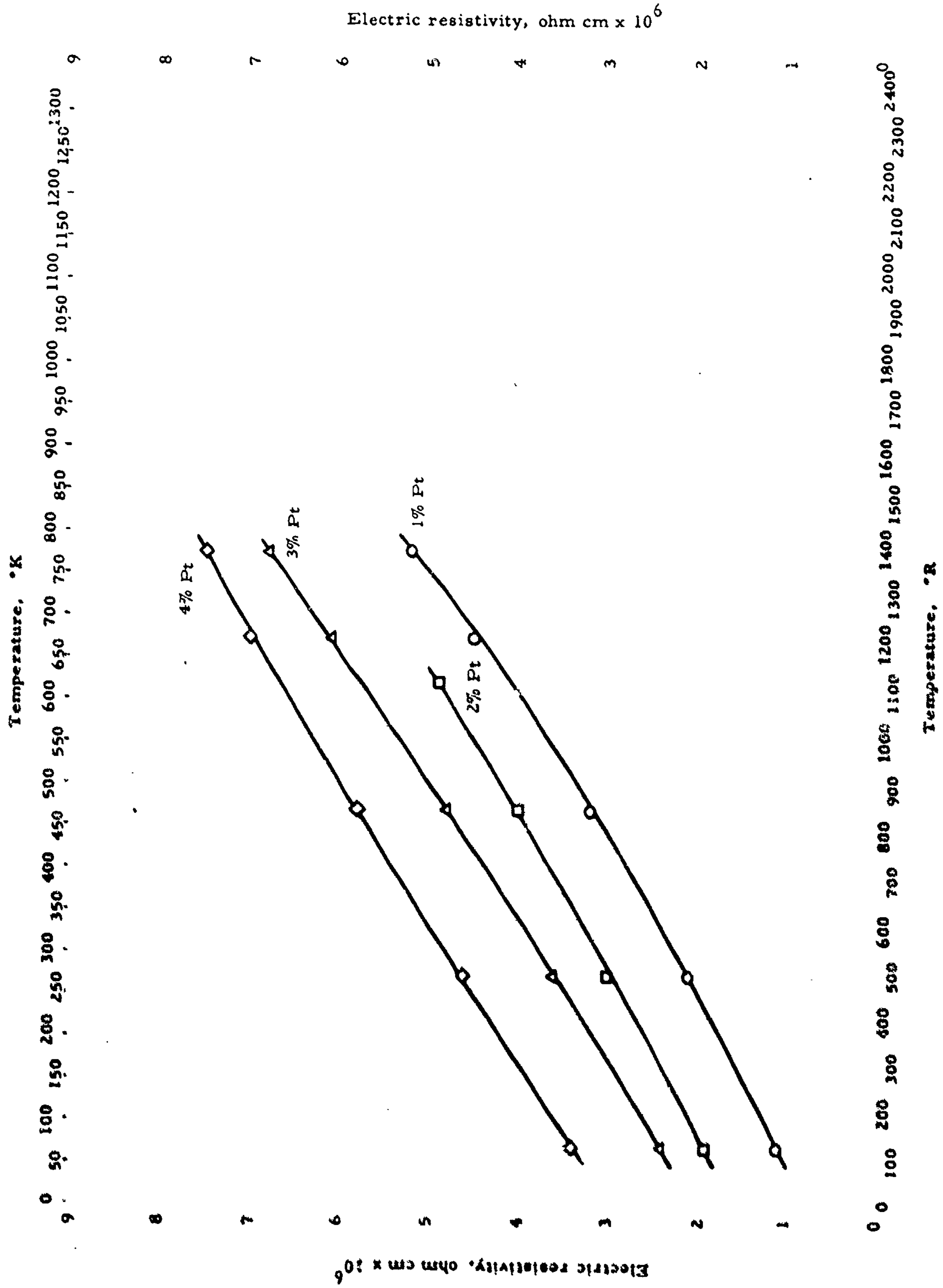


ELECTRIC RESISTIVITY -- SILVER + MANGANESE

ELECTRIC RESISTIVITY -- SILVER + MANGANESE

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gerritsen, A.N. and Linde, J.O.	51-17	180-492	Nominal: 0.025% Mn	High resistance DC bridge	Prepared from pure Ag and Mn containing 0.01% Ca; 0.004% Si; 0.003% Fe
□	Ibid.	51-17	180-492	Nominal: 0.056% Mn	Same as above	Same as above
△	Ibid.	51-17	180-492	Nominal: 0.071% Mn	Same as above	Same as above
◇	Ibid.	51-17	180-492	Nominal: 0.12% Mn	Same as above	Same as above
▽	Ibid.	51-17	180-492	Nominal: 0.16% Mn	Same as above	Same as above
○	Ibid.	51-17	180-492	Nominal: 0.20% Mn	Same as above	Same as above
□	Ibid.	51-17	180-492	Nominal: 0.28% Mn	Same as above	Same as above
△	Ibid.	51-17	180-492	Nominal: 0.37% Mn	Same as above	Same as above
□	Ibid.	51-17	180-492	Nominal: 0.738% Mn	Same as above	Same as above
▽	Ibid.	51-17	180-492	Nominal: 2.26% Mn	Same as above	Same as above
△	Ibid.	51-17	180-492	Nominal: 5.52% Mn	Same as above	Same as above
○	Ibid.	51-17	180-492	Nominal: 9.93% Mn	Same as above	Same as above
◇	Otter, F.A.	56-46	132-1212	1.0% Mn	Potential drop inside a heavy copper shield. Sample temp. by thermocouple	Made from 99.99% pure metals. Melted 100°C above MP, homogenized 24 hr. at 900°C, swaged to 0.030" dia., annealed 1 hr. at 500°C
▷	Ibid.	56-46	132-1392	2.0% Mn	Same as above	Same as above
○	Ibid.	56-46	132-492	4.0% Mn	Same as above	Same as above
◁	Ibid.	56-46	132-1392	6.0% Mn	Same as above	Same as above

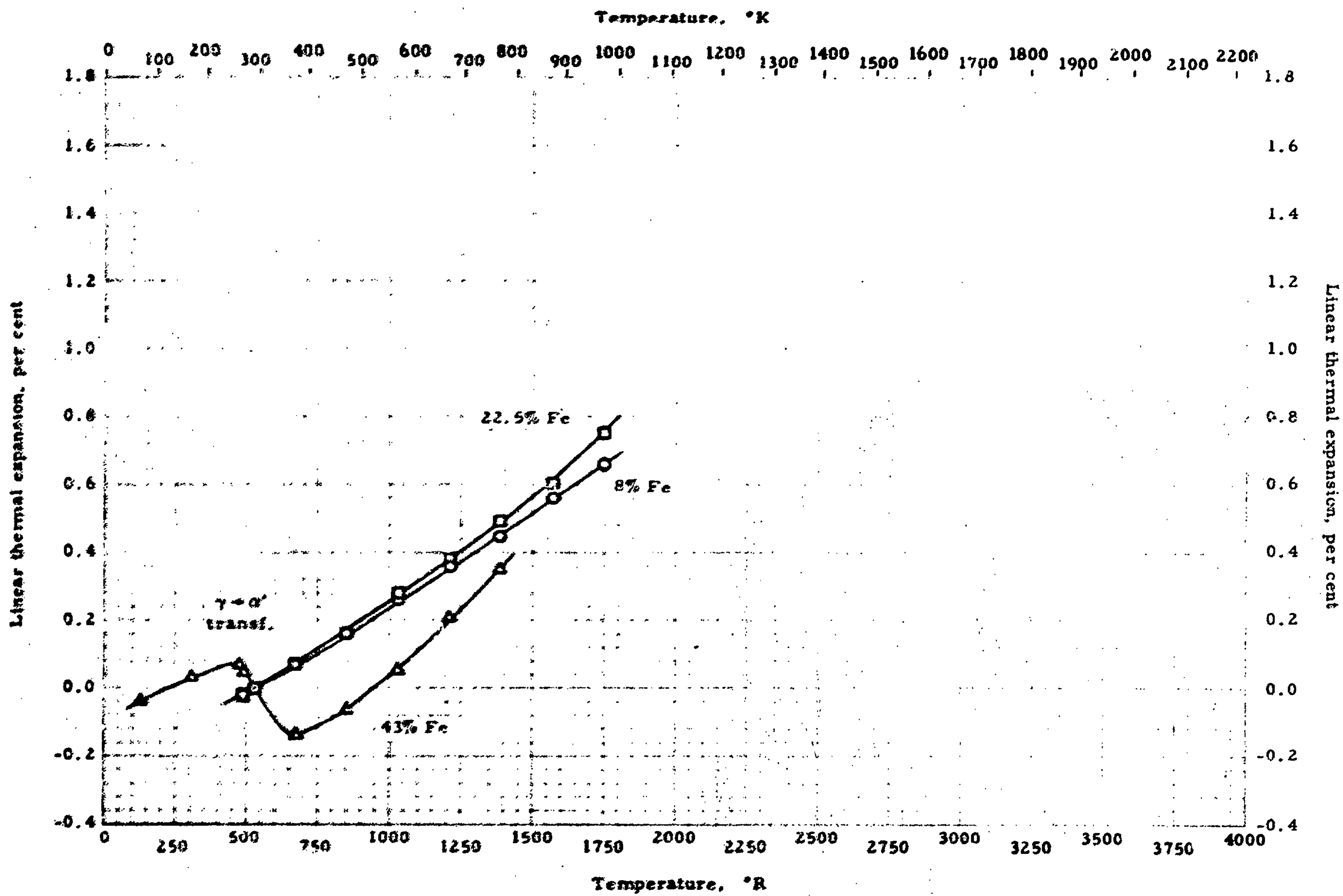


ELECTRIC RESISTIVITY -- SILVER + PLATINUM

ELECTRIC RESISTIVITY -- SILVER + PLATINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Otter, F.A.	56-46	132-1392	1.0% Pt	Potential drop inside a heavy copper shield. Pt-Rh thermocouple	Vac. Melted from 99.99% pure metals by 100°C above MP, homogenized 24 hr. at 900°C, swaged to 0.030" dia., annealed 1 hr. at 500°C
□	Ibid.	56-46	132-1392	2.0% Pt	Same as above	Same as above
△	Ibid.	56-46	132-1392	3.0% Pt	Same as above	Same as above
◇	Ibid.	56-46	132-1392	4.0% Pt	Same as above	Same as above

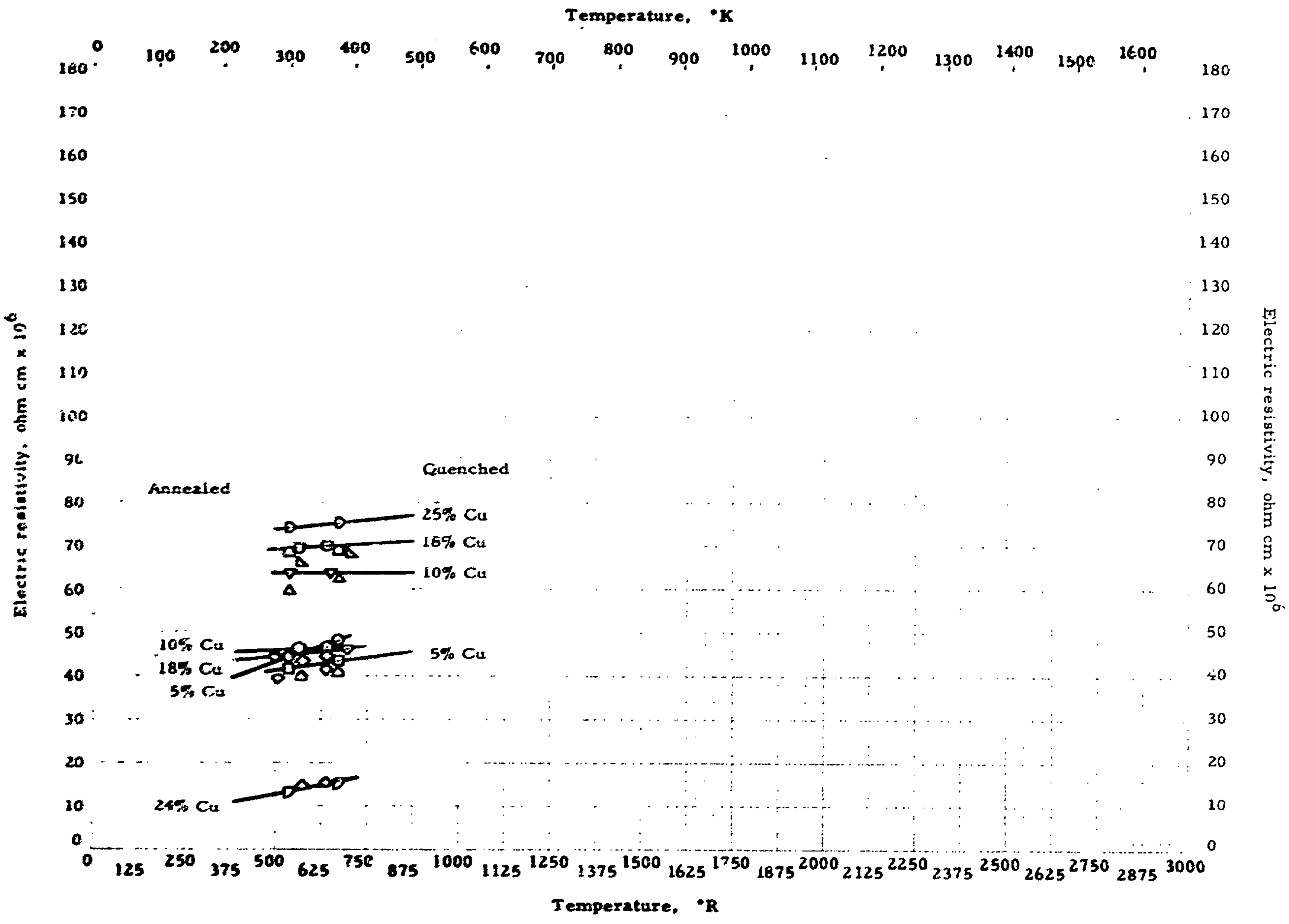


LINEAR THERMAL EXPANSION -- PLATINUM + IRO[N]

LINEAR THERMAL EXPANSION -- PLATINUM + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kussman, A. and Rittberg, G. Grfn.	50-9	492-1752	92% Pt; 8% Fe	Not given	Prepared from Armco iron and technically pure platinum, melted in magnesia crucible, formed into rods, tempered
□	Ibid.	50-9	492-1752	77.5% Pt; 22.5% Fe	Same as above	Same as above
△	Ibid.	50-9	132-1392	57% Pt; 43% Fe	Same as above	Same as above

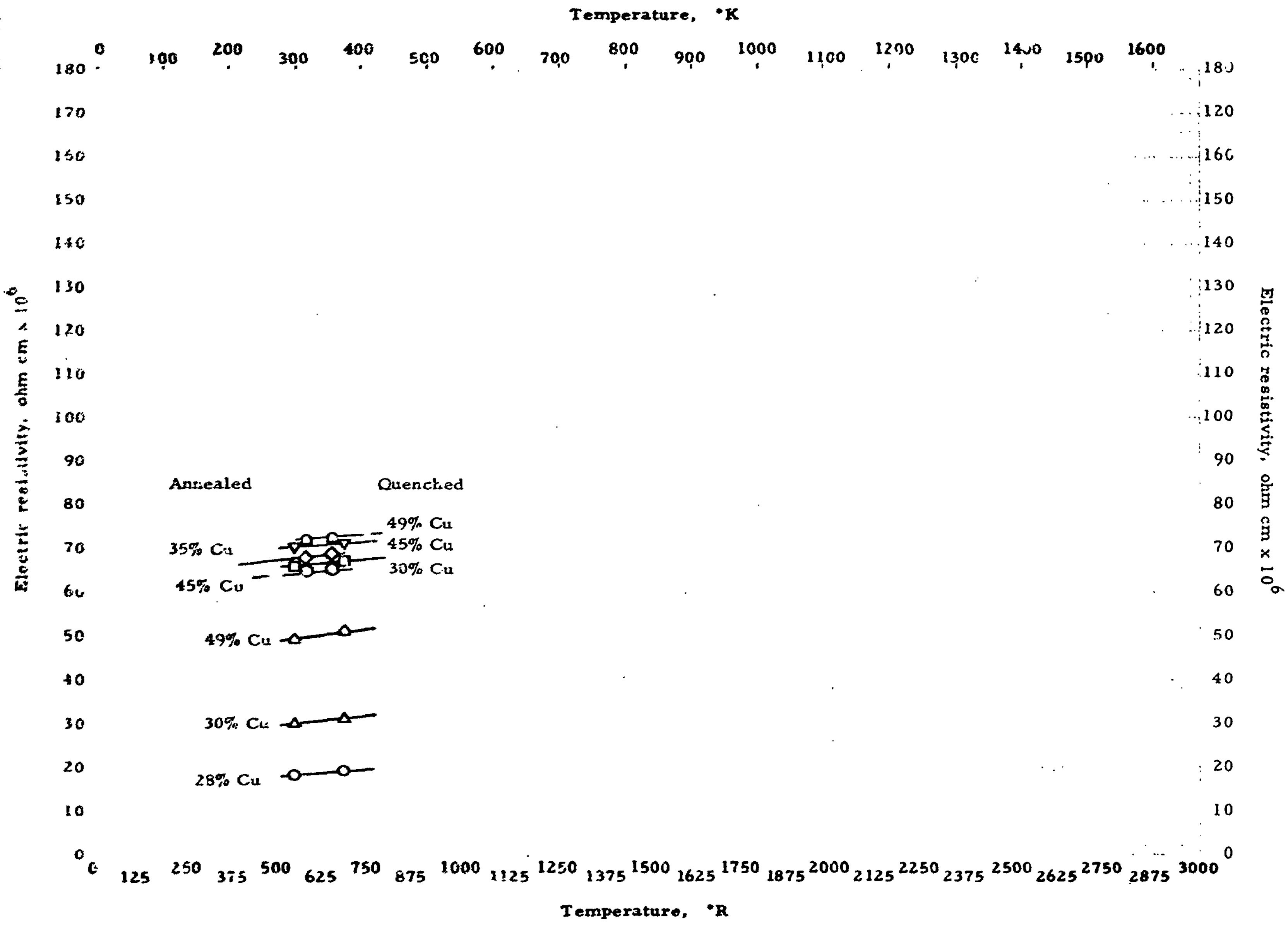


ELECTRIC RESISTIVITY -- PLATINUM + COPPER
(0-25% Cu)

ELECTRIC RESISTIVITY -- PLATINUM + COPPER
(0 - 25% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Rudnitskii, A. A.	56-70	537-672	4.54% Cu	Potential drop	Quenched from 900 °C
□	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
△	Ibid.	56-70	537-672	7.45% Cu	Same as above	Quenched from 900 °C
◇	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
▽	Ibid.	56-70	537-672	10.09% Cu	Same as above	Quenched from 900 °C
○	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
⌂	Ibid.	56-70	537-672	12.45% Cu	Same as above	Quenched from 900 °C
⌂	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
□	Ibid.	56-70	537-672	17.56% Cu	Same as above	Quenched from 900 °C
▽	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
◺	Ibid.	56-70	537-672	21.56% Cu	Same as above	Quenched from 900 °C
◇	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
▷	Ibid.	56-70	537-672	23.22% Cu	Same as above	Same as above
▷	Ibid.	56-70	537-672	24.76% Cu	Same as above	Quenched from 900 °C
⌂	Ibid.	56-70	527-672	Same as above	Same as above	Annealed

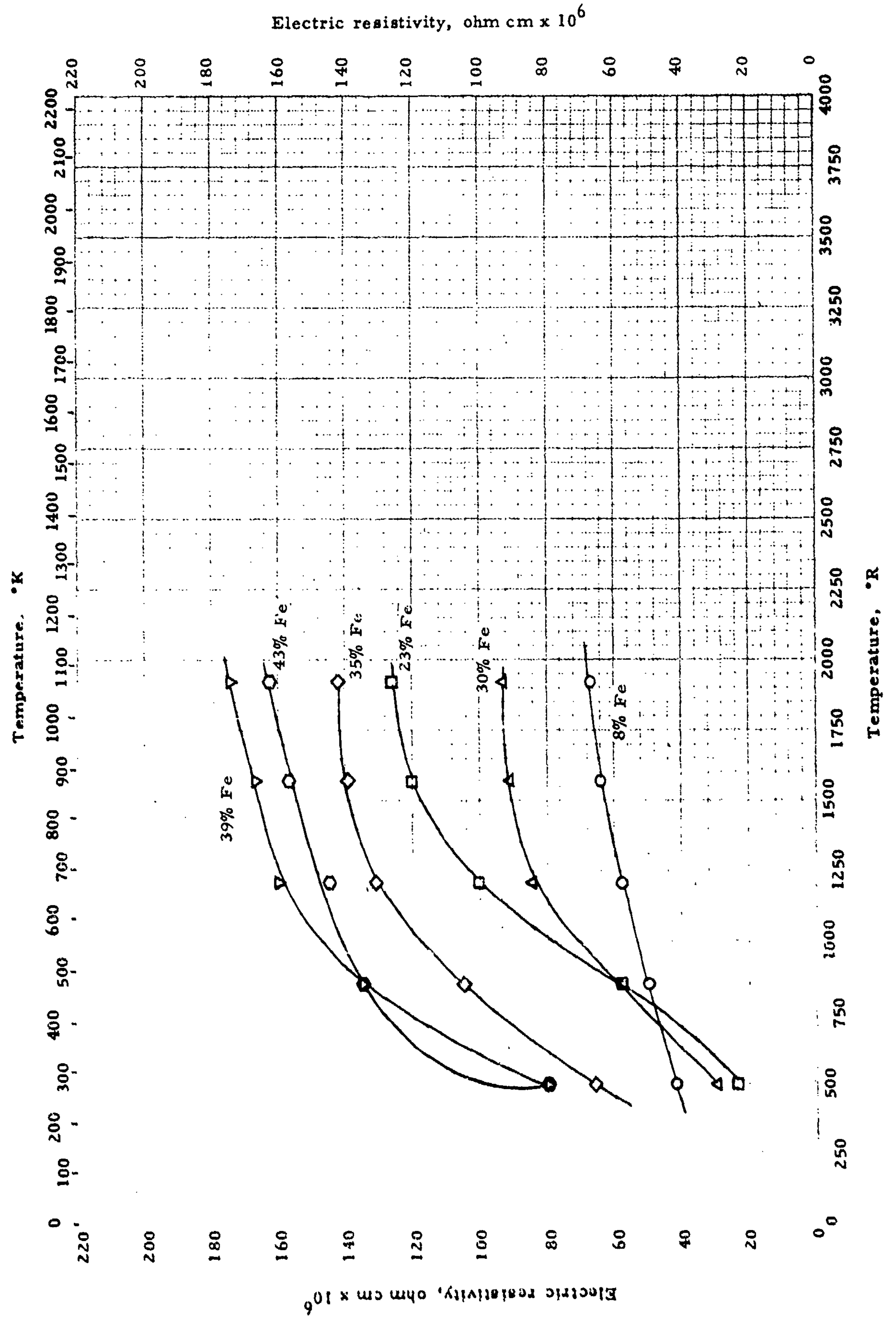


ELECTRIC RESISTIVITY -- PLATINUM + COPPER
(25 - 50% Cu)

ELECTRIC RESISTIVITY -- PLATINUM + COPPER
(25 - 50% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Rudnitskii, A. A.	56-70	537-672	28.14% Cu	Potential drop	Annealed
□	Ibid.	56-70	537-672	30.15% Cu	Same as above	Quenched from 900 °C
△	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
◇	Ibid.	56-70	537-672	34.73% Cu	Same as above	Annealed
▽	Ibid.	56-70	537-672	44.82% Cu	Same as above	Quenched from 900 °C
◗	Ibid.	56-70	537-672	Same as above	Same as above	Annealed
⌂	Ibid.	56-70	537-672	49.14% Cu	Same as above	Quenched from 900 °C
⌓	Ibid.	56-70	537-672	Same as above	Same as above	Annealed



ELECTRIC RESISTIVITY -- PLATINUM + IRON

ELECTRIC RESISTIVITY -- PLATINUM + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kussman, A. and Rittberg, G. Grfn.	50-9	492-1932	92% Pt; 8% Fe. Prepared from Armco Fe and technically pure Pt	Not given	Induction melted in MgO crucible; tempered
□	Ibid.	50-9	492-1932	77.5% Pt; 22.5% Fe. Prepared as above	Same as above	Same as above
△	Ibid.	50-9	492-1932	70% Pt; 30% Fe. Prepared as above	Same as above	Same as above
◇	Ibid.	50-9	492-1932	65% Pt; 35% Fe. Prepared as above	Same as above	Same as above
▽	Ibid.	50-9	492-1932	61% Pt; 39% Fe. Prepared as above	Same as above	Same as above
◌	Ibid.	50-9	492-1932	57% Pt; 43% Fe. Prepared as above	Same as above	Same as above

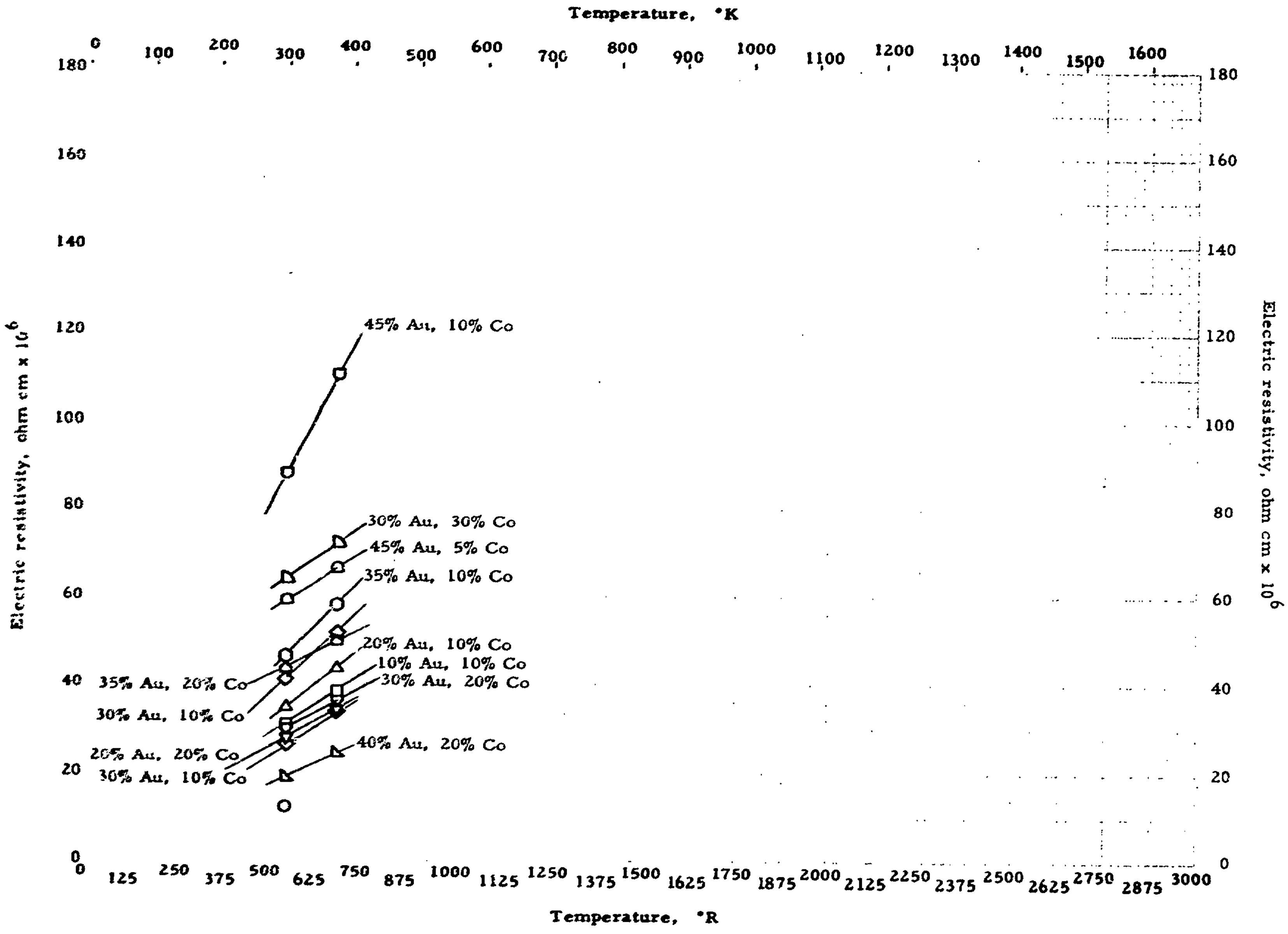
Symbol	Nominal Composition, %			Melting Point	
	Pd	Au	Co	°R	°K
O	90.2	5.1	4.7	2972	1651
	80.0	10.2	9.8	2889	1605
	70.0	20.0	10.0	2864	1591
	60.0	30.0	10.0	2821	1567
	60.0	20.0	20.0	2702	1501
	55.0	35.0	10.0	2796	1553
	50.0	45.0	5.0	2886	1603
	50.0	40.0	10.0	2796	1553
	50.0	30.0	20.0	2639	1466
	45.0	45.0	10.0	2760	1533
	45.0	35.0	20.0	2634	1463
	40.0	40.0	20.0	2639	1466
	40.0	35.0	20.0	2626	1459
	40.0	30.0	30.0	2634	1463

MELTING POINT -- PALLADIUM + GOLD + COBALT

MELTING POINT -- PALLADIUM + GOLD + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A.T., Sokolovskaya, E.M., .udennaya, L.D. et al.	56-32	2626-2972	Ternary system: 40-90% Pd; 5.1-45% Au; 4.7-30% Co. Ingredients with <0.01% impurities	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled



ELECTRIC RESISTIVITY -- PALLADIUM + GOLD + COBALT

ELECTRIC RESISTIVITY -- PALLADIUM + GOLD + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M. et al.	56-32	537-672	90.2% Pd; 5.1% Au; 4.7% Co	Potential drop	Annealed 100-150 hr. close to solidus temp., in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	80.0% Pd; 10.2% Au; 9.8% Co	Same as above	Same as above
△	Ibid.	56-32	537-672	70% Pd; 20% Au; 10% Co	Same as above	Same as above
◇	Ibid.	56-32	537-672	60% Pd; 30% Au; 10% Co	Same as above	Same as above
▽	Ibid.	56-32	537-672	60% Pd; 20% Au; 20% Co	Same as above	Same as above
○	Ibid.	56-32	537-672	55% Pd; 35% Au; 10% Co	Same as above	Same as above
⌂	Ibid.	56-32	537-672	50% Pd; 45% Au; 5% Co	Same as above	Same as above
▽	Ibid.	56-32	537-672	50% Pd; 30% Au; 20% Co	Same as above	Same as above
□	Ibid.	56-32	537-672	45% Pd; 45% Au; 10% Co	Same as above	Same as above
⌂	Ibid.	56-32	537-672	45% Pd; 35% Au; 20% Co	Same as above	Same as above
◺	Ibid.	56-32	537-672	40% Pd; 40% Au; 20% Co	Same as above	Same as above
◇	Ibid.	56-32	537-672	40% Pd; 35% Au; 25% Co	Same as above	Same as above
◺	Ibid.	56-32	537-672	40% Pd; 30% Au; 30% Co	Same as above	Same as above

Symbol	Nominal Composition, %			Melting Point	
	Pd	Co	Cu	°R	°K
O	89.0	5.6	5.4	2911	1617
	69.1	18.6	12.3	2614	1452
	60.0	30.0	10.0	2598	1443
	60.0	20.0	20.0	2544	1413
	47.7	41.2	11.1	2581	1434
	47.0	32.2	20.8	2520	1400

MELTING POINT -- PALLADIUM + COBALT + COPPER

MELTING POINT -- PALLADIUM + COBALT + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A.T., Panteleimonov, L. A., Kuprina, V. V., et al.	56-31	2520-2911	Ternary system: 47-89% Pd; 5.6-41.2% Co; 5.4-20.8% Cu	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	

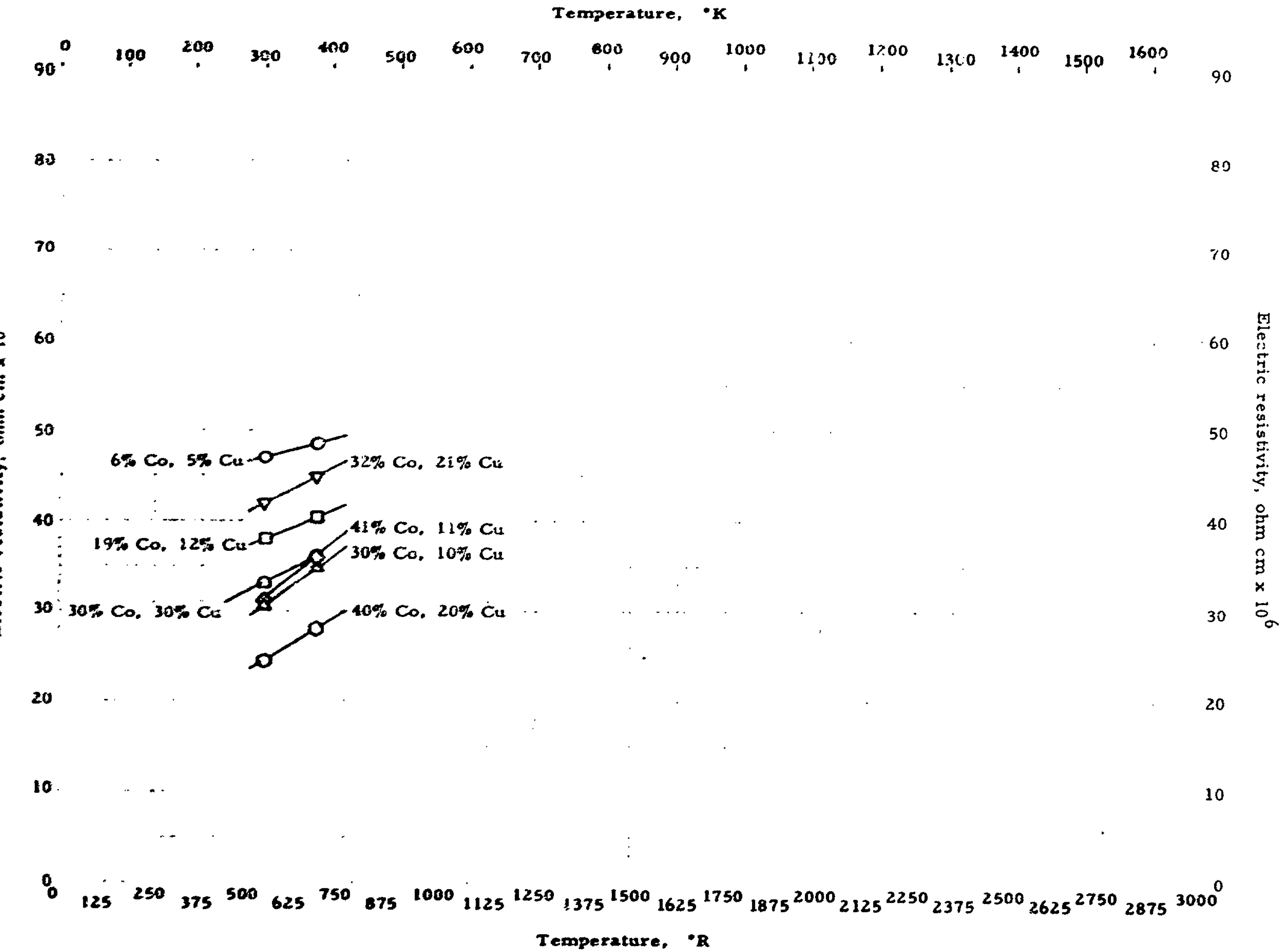
Symbol	Nominal Composition, %			Melting Point	
	Pd	Co	Au	°R	°K
O	70.1	19.6	10.3	2826	1570
	60.2	29.6	10.2	2634	1463
	60.0	20.0	20.0	2702	1501
	55.3	29.5	25.2	2637	1465
	55.1	34.7	10.2	2670	1483
	55.0	20.0	15.0	2688	1493
	50.3	39.5	10.2	2670	1483
	50.1	29.7	20.2	2634	1463
	50.0	45.0	5.0	2675	1486
	45.3	39.5	15.2	2652	1473
	45.1	29.8	25.1	2626	1459
	40.0	40.0	20.0	2634	1463
	40.0	30.0	30.0	2634	1463

MELTING POINT -- PALLADIUM + COBALT + GOLD

PROPERTIES OF PALLADIUM + COBALT + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigor'ev, A. T., Sokolovskaya, E. M., Budennaya, L. D. et al.	56-32	2626-2826	Ternary system: 40-70.1% Pd; 19.6-45% Co; 5-30% Au. Ingredients with <0.01% impurities	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	Samples annealed in vacuum 100-150 hr. close to solidus temp. and slowly cooled

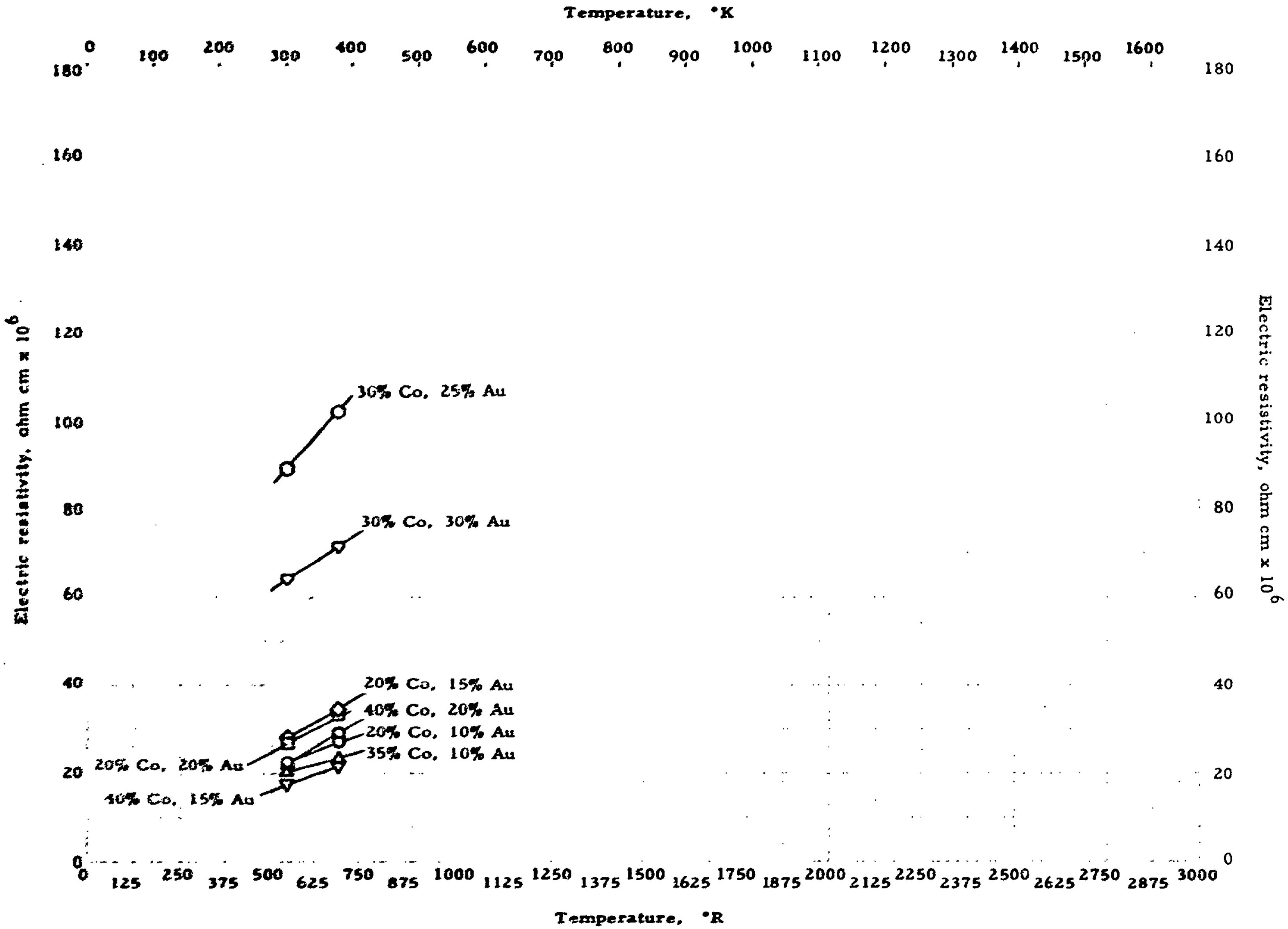


ELECTRIC RESISTIVITY -- PALLADIUM + COBALT + COPPER

ELECTRIC RESISTIVITY -- PALLADIUM + COBALT + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., et al.	56-31	537-672	89.0% Pd; 5.6% Co; 5.4% Cu	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	69.1% Pd; 18.6% Co; 12.3% Cu	Same as above	Same as above
△	Ibid.	56-31	537-672	60.0% Pd; 30.0% Co; 10.0% Cu	Same as above	Same as above
◇	Ibid.	56-31	537-672	47.7% Pd; 41.2% Co; 11.1% Cu	Same as above	Same as above
▽	Ibid.	56-31	537-672	47.0% Pd; 32.2% Co; 20.8% Cu	Same as above	Same as above
○	Ibid.	56-31	537-672	40.0% Pd; 40.0% Co; 20.0% Cu	Same as above	Same as above
○	Ibid.	56-31	537-672	40.0% Pd; 30.0% Co; 30.0% Cu	Same as above	Same as above



ELECTRIC RESISTIVITY -- PALLADIUM + COBALT + GOLD

ELECTRIC RESISTIVITY -- PALLADIUM + COBALT + GOLD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Sokolovskaya, E. M., et al.	56-32	537-672	70.1% Pd; 19.6% Co; 10.3% Au	Potential drop	Annealed 100-150 hr. close to solidus temp. in vacuum; cooled slowly to room temp.
□	Ibid.	56-32	537-672	60% Pd; 20% Co; 20% Au	Same as above	Same as above
△	Ibid.	56-32	537-672	55.1% Pd; 34.7% Co; 10.2% Au	Same as above	Same as above
◇	Ibid.	56-32	537-672	55% Pd; 20% Co; 15% Au	Same as above	Same as above
▽	Ibid.	56-32	537-672	45.3% Pd; 39.5% Co; 15.2% Au	Same as above	Same as above
○	Ibid.	56-32	537-672	45.1% Pd; 29.8% Co; 25.1% Au	Same as above	Same as above
◻	Ibid.	56-32	537-672	40% Pd; 40% Co; 20% Au	Same as above	Same as above
▽	Ibid.	56-32	537-672	40% Pd; 30% Co; 30% Au	Same as above	Same as above

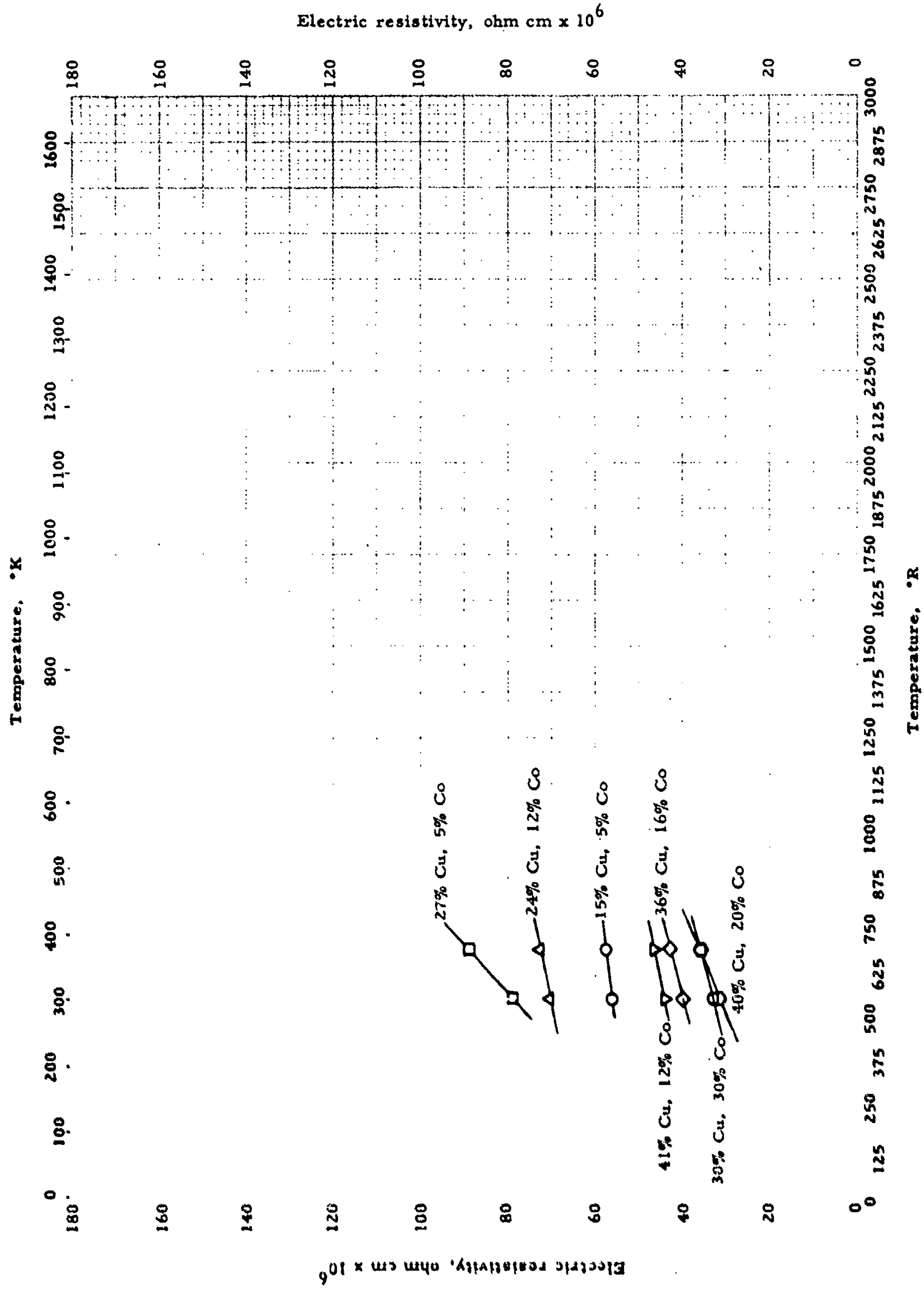
Symbol	Nominal Composition, %			Melting Point	
	Pd	Cu	Co	°R	°K
O	68.5	26.5	5.0	2583	1435
	68.5	21.0	10.5	2569	1427
	60.0	20.0	20.0	2544	1413
	59.1	29.0	11.9	2531	1406
	48.0	35.7	16.3	2490	1383
	47.6	41.3	12.1	2508	1393

MELTING POINT -- PALLADIUM + COPPER + COBALT

MELTING POINT -- PALLADIUM + COPPER + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Grigorev, A.T., Panteleimonov, L.A., Kuprina, V.V. et al.	56-31	2490-2583	Ternary system; 47.6-68.5% Pd; 20-41.3% Cu; 5-20% Co	MP: break in time-temp. curve during cooling; Pt-Rh thermocouple	



ELECTRIC RESISTIVITY -- PALLADIUM + COPPER + COBALT

ELECTRIC RESISTIVITY -- PALLADIUM + COPPER + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Grigor'ev, A. T., Panteleimonov, L. A., et al.	56-31	537-672	80% Pd; 15% Cu; 5% Co	Potential drop	Annealed 150 hr. at 1000°C in vacuum; cooled in 10 hr.
□	Ibid.	56-31	537-672	68.5% Pd; 26.5% Cu; 5.0% Co	Same as above	Same as above
△	Ibid.	56-31	537-672	59.1% Pd; 24.0% Cu; 11.9% Co	Same as above	Same as above
◇	Ibid.	56-31	537-672	48.0% Pd; 35.7% Cu; 16.3% Co	Same as above	Same as above
▽	Ibid.	56-31	537-672	47.6% Pd; 41.3% Cu; 12.1% Co	Same as above	Same as above
○	Ibid.	56-31	537-672	40% Pd; 40% Cu; 20% Co	Same as above	Same as above
□	Ibid.	56-31	537-672	40% Pd; 30% Cu; 30% Co	Same as above	Same as above

PROPERTIES OF PALLADIUM + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point UPd_3 . . .	3440°R	1910°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

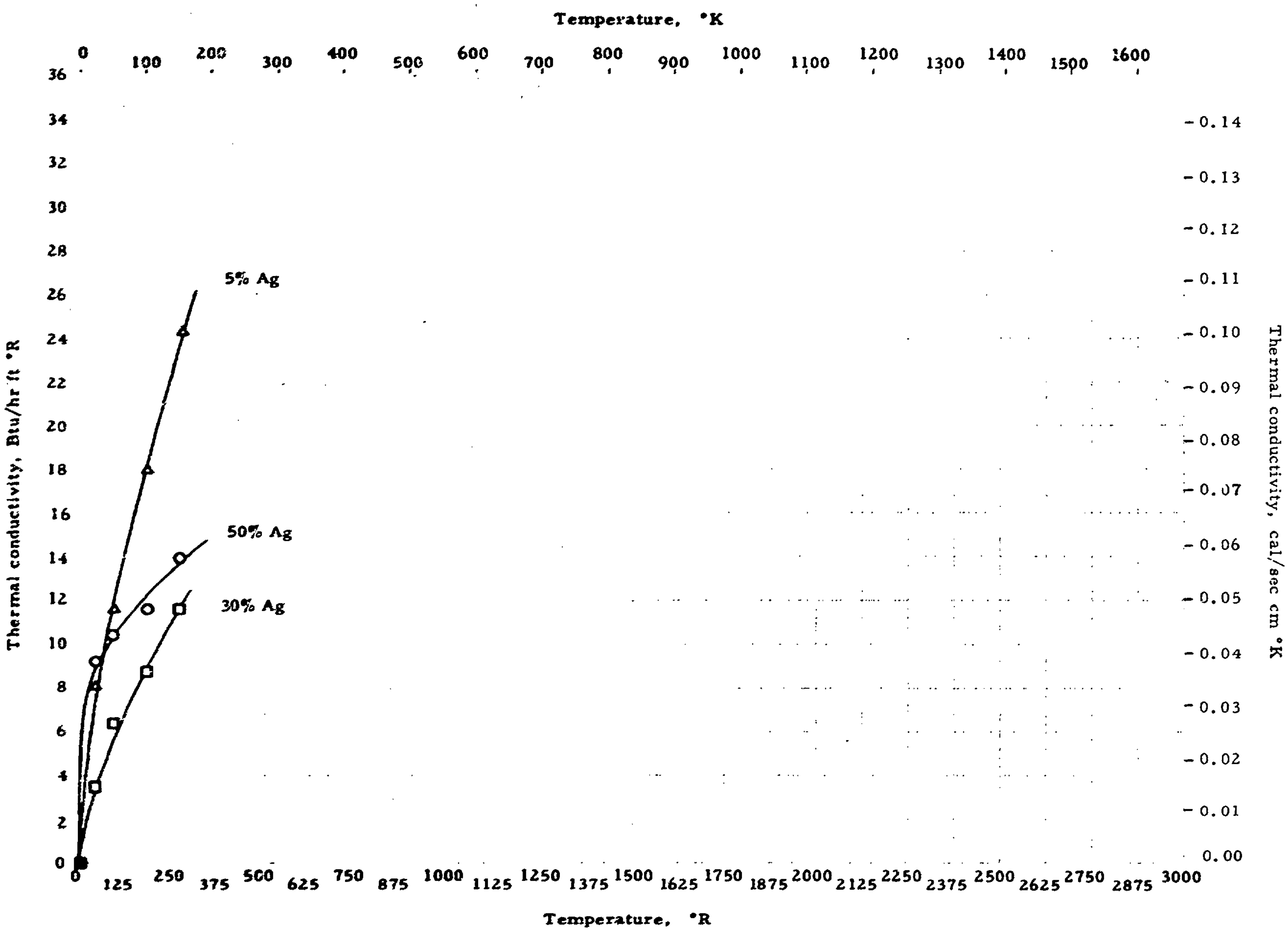
REPORTED VALUES

Density:	lb_m/ft^3	g/cm^3
Melting Point:	°R	°K
O	3444	1913
Heat of Fusion:	Btu/lb_m	cal/g
Heat of Vaporization:	Btu/lb_m	cal/g
Heat of Sublimation:	Btu/lb_m	cal/g

PROPERTIES OF PALLADIUM + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
C	Catterall, J.A., Grogan, J.D. and Pleasance, R.J.	56-85	1640	UPd_3: 57.28% Pd; 42.72% U	MP: break in time-temp. curve, temp. by Pt-PtRh thermocouple	

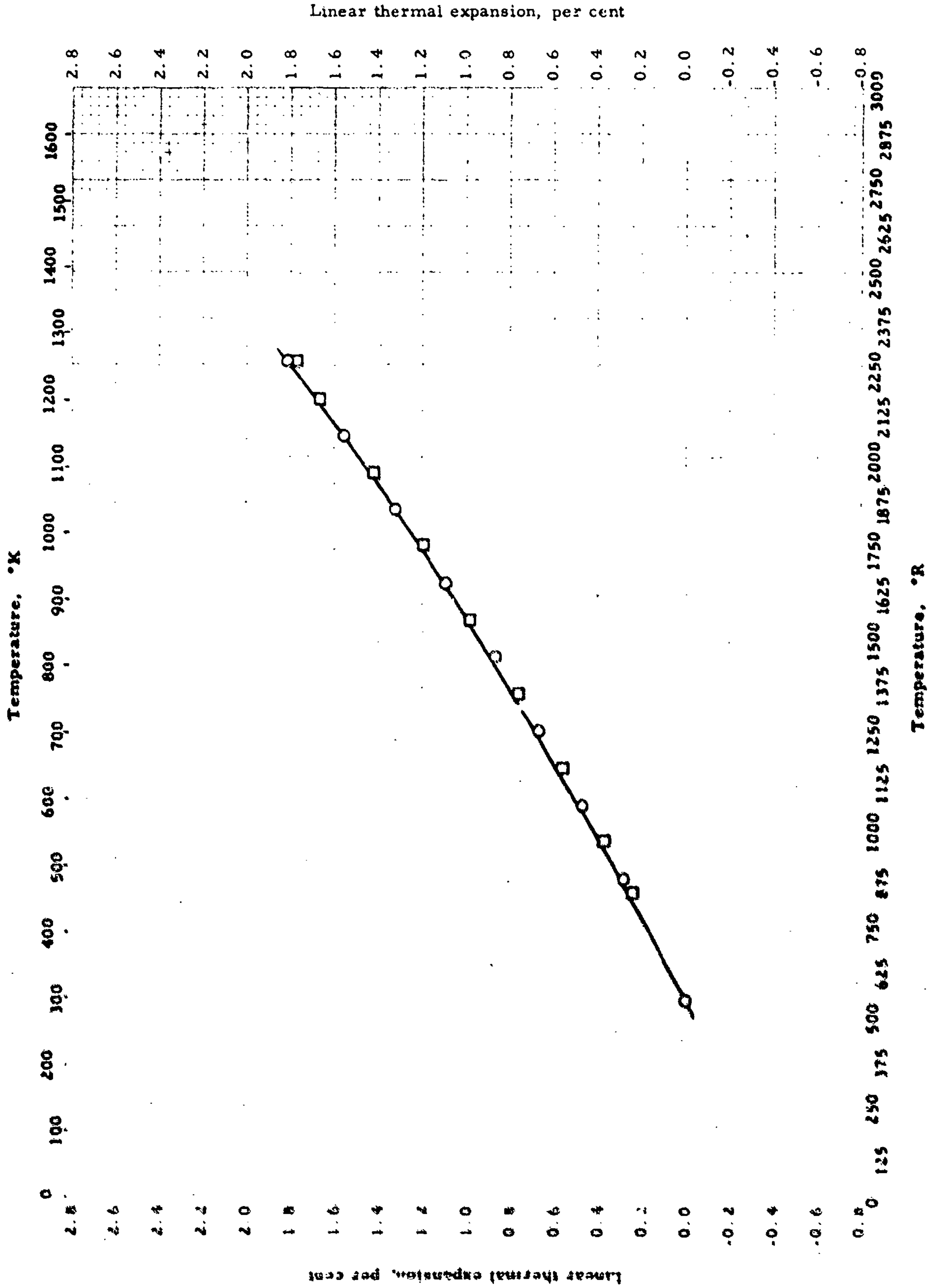


THERMAL CONDUCTIVITY -- PALLADIUM + SILVER

THERMAL CONDUCTIVITY -- PALLADIUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W.R.G., Klemens, P.G. et al.	56-30	3-288	50% Ag	Axial heat flow in rod heated at one end, guarded heat source and sample	Annealed at 880°C
□	Ibid.	56-30	3-288	30% Ag		Same as above
△	Ibid.	56-30	3-288	5 % Ag		Same as above

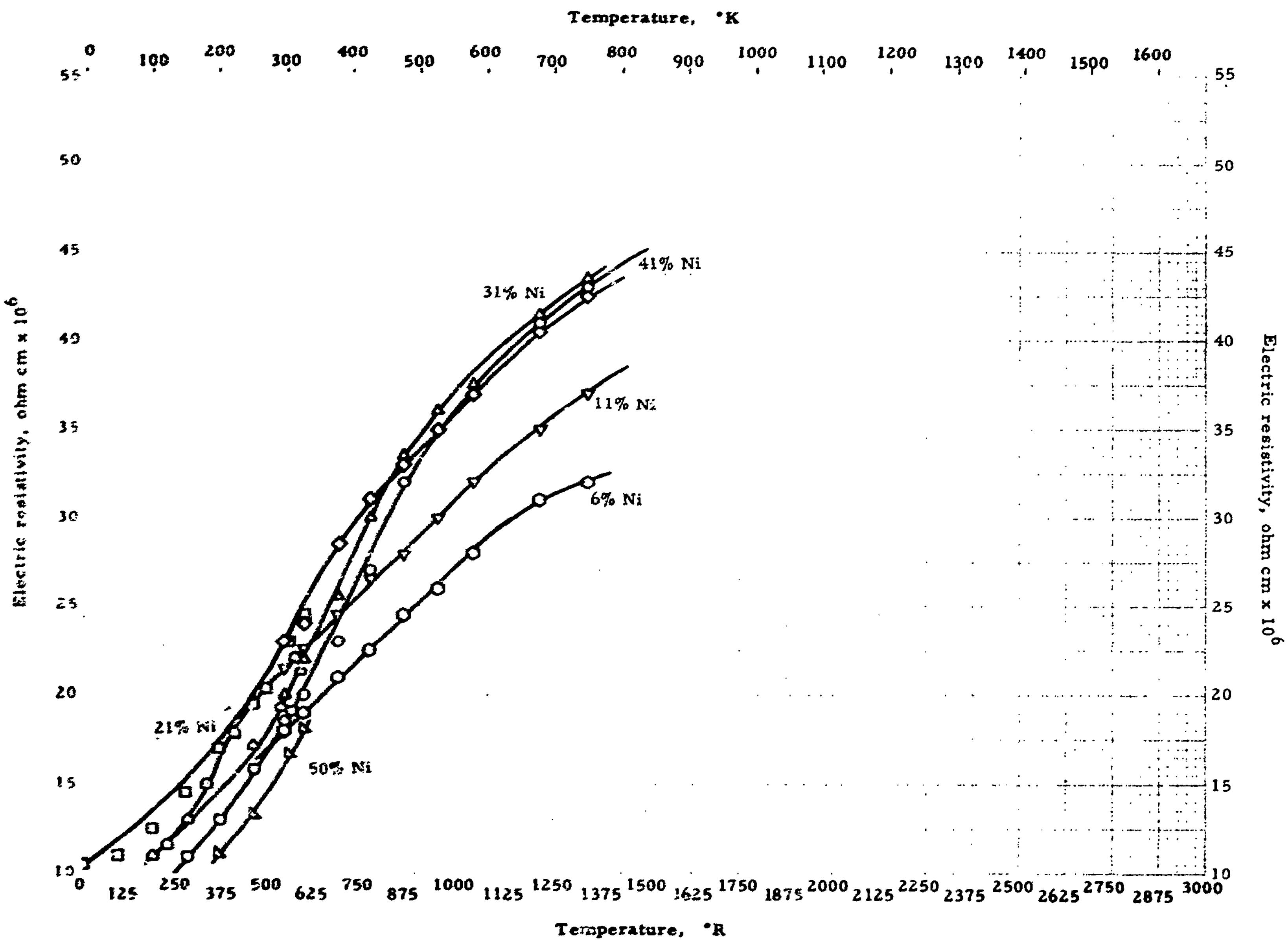


LINEAR THERMAL EXPANSION -- PALLADIUM + NICKEL + X

LINEAR THERMAL EXPANSION -- PALLADIUM + NICKEL + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Seller, H.A., Stacy, J.T. and Klebanow, H.L.	54-116	528-2260	GE-76 Brazing Alloy. Nominal: 44% Pd; 33% Ni; 23% Cr. Analysis shows 0.05% Si; 0.014% S	Recording dilatometer tested in 40 μ Hg vac. at 5.4°F/min. temp. rise	As cast; data avg. of two complete heating and cooling cycles. Auth. est. accuracy ± 2%
□	Ibid.	54-116	528-2260	Same as above	Same as above	Cast, heat treated 24 hr. at 2000°F in argon atm. Data avg. of two complete heating and cooling cycles. Auth. est. accuracy ± 2%

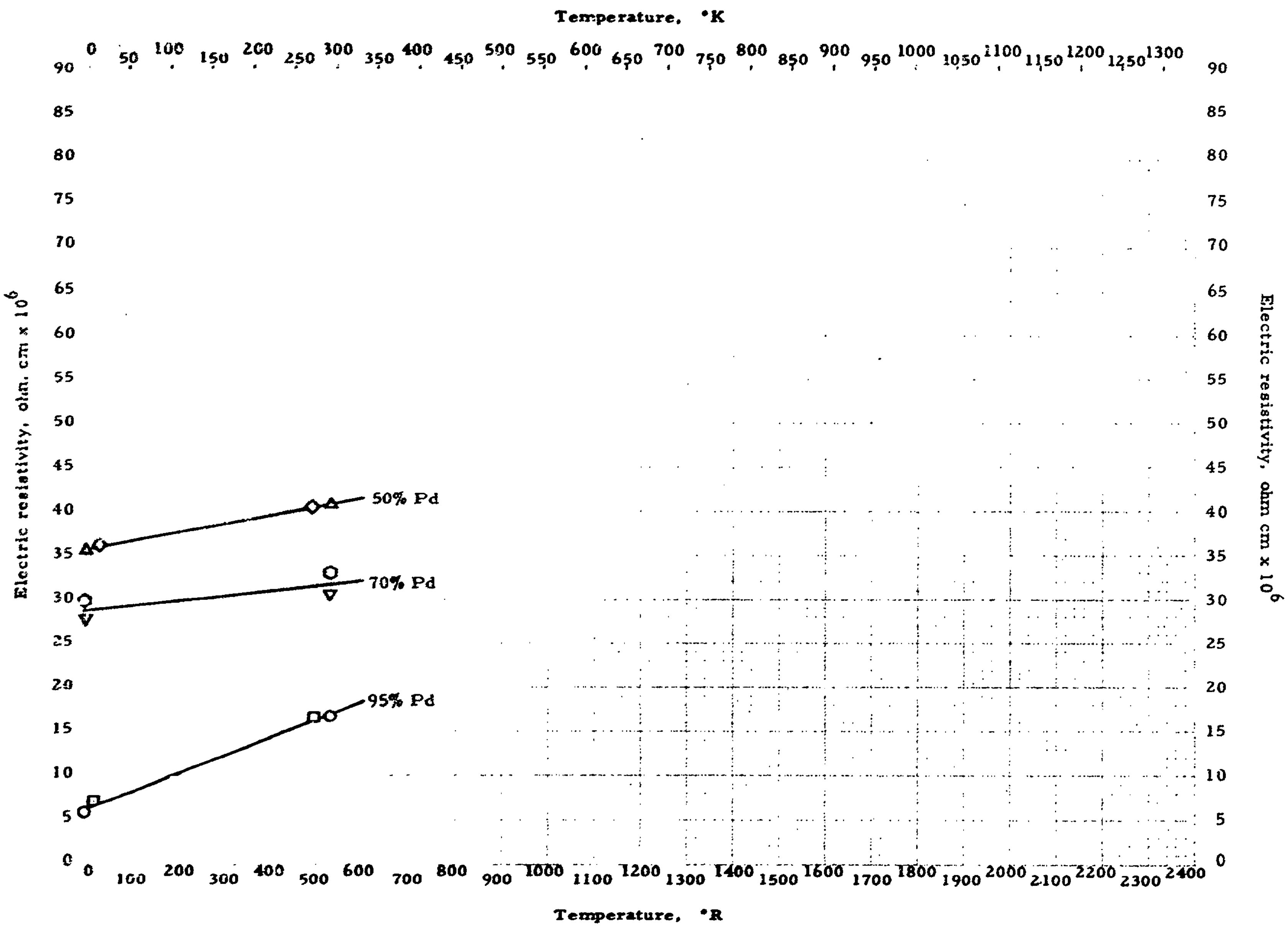


ELECTRIC RESISTIVITY -- PALLADIUM + NICKEL

ELECTRIC RESISTIVITY -- PALLADIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Schindler, A. J., Smith, R. J. and Salkovitz, E. I.	57-18	528-1338	59.2% Pd; 40.8% Ni	Kelvin bridge	Annealed 2 hr. at 1070°K in vacuum and furnace cooled 24 hr.
△	Ibid.	57-18	528-1338	69.1% Pd; 30.9% Ni	Same as above	Same as above
◇	Ibid.	57-18	528-1338	79.0% Pd; 21.0% Ni	Same as above	Same as above
▽	Ibid.	57-18	528-1338	89.5% Pd; 10.5% Ni	Same as above	Same as above
○	Ibid.	57-18	528-1338	94.2% Pd; 5.8% Ni	Same as above	Same as above
□	Schindler, A. J., Smith, R. J. and Salkovitz, E. I.	56-16	0-585	79.4% Pd; 20.6% Ni	Kelvin bridge	Annealed 2 hr. at 800°C in vacuum and gradually cooled 24 hr.
◘	Ibid.	56-16	180-585	89.4% Pd; 10.6% Ni	Same as above	Same as above
◒	Ibid.	56-16	180-585	70% Pd; 30% Ni	Same as above	Same as above
◓	Ibid.	56-16	180-585	57.4% Pd; 42.6% Ni	Same as above	Same as above
◭	Ibid.	56-16	360-585	Two samples: a) 50.2% Ni; 49.8% Pd b) 61% Ni; 39% Pd	Same as above	Same as above. Plotted avg. of 2 samples with max. dev. ± 3%

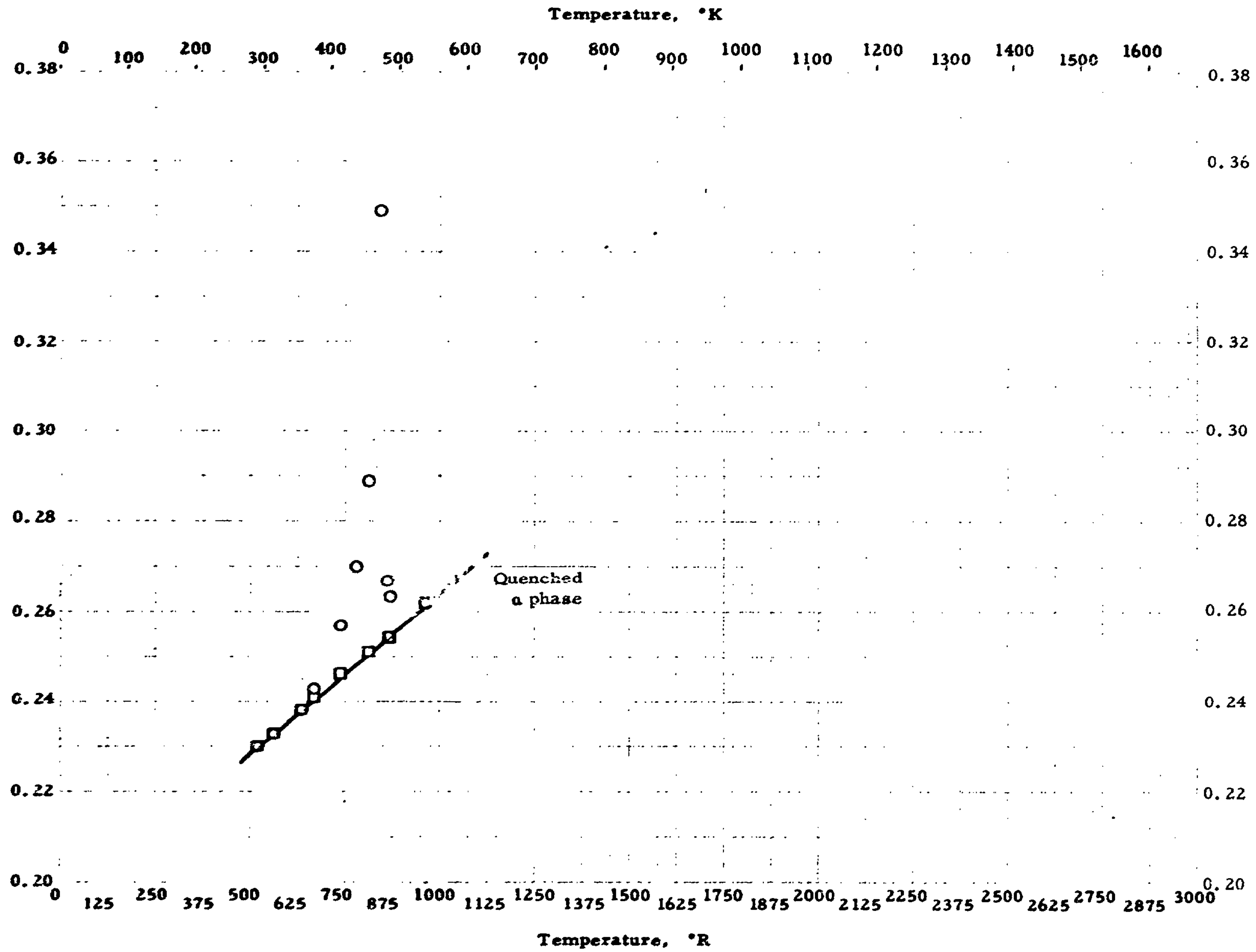


ELECTRIC RESISTIVITY -- PALLADIUM + SILVER

ELECTRIC RESISTIVITY -- PALLADIUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kemp, W.R.G., Klemens, P.G. et al.	56-30	0-528	95% Pd	Not described here, refers to others	Rod, annealed at 880 °C
□	Ibid.	56-30	0-528	Same as above	Same as above	Wire, annealed at 880 °C, wound on mica former, then reannealed at 500 °C
△	Ibid.	56-30	0-528	70% Pd	Same as above	Rod, annealed at 880 °C
◇	Ibid.	56-30	0-528	Same as above	Same as above	Wire, annealed at 880 °C, wound on mica former, then reannealed at 500 °C
▽	Ibid.	56-30	0-528	50% Pd	Same as above	Rod, annealed at 880 °C
○	Ibid.	56-30	0-528	Same as above	Same as above	Wire, annealed at 880 °C, wound on mica former, then reannealed at 500 °C

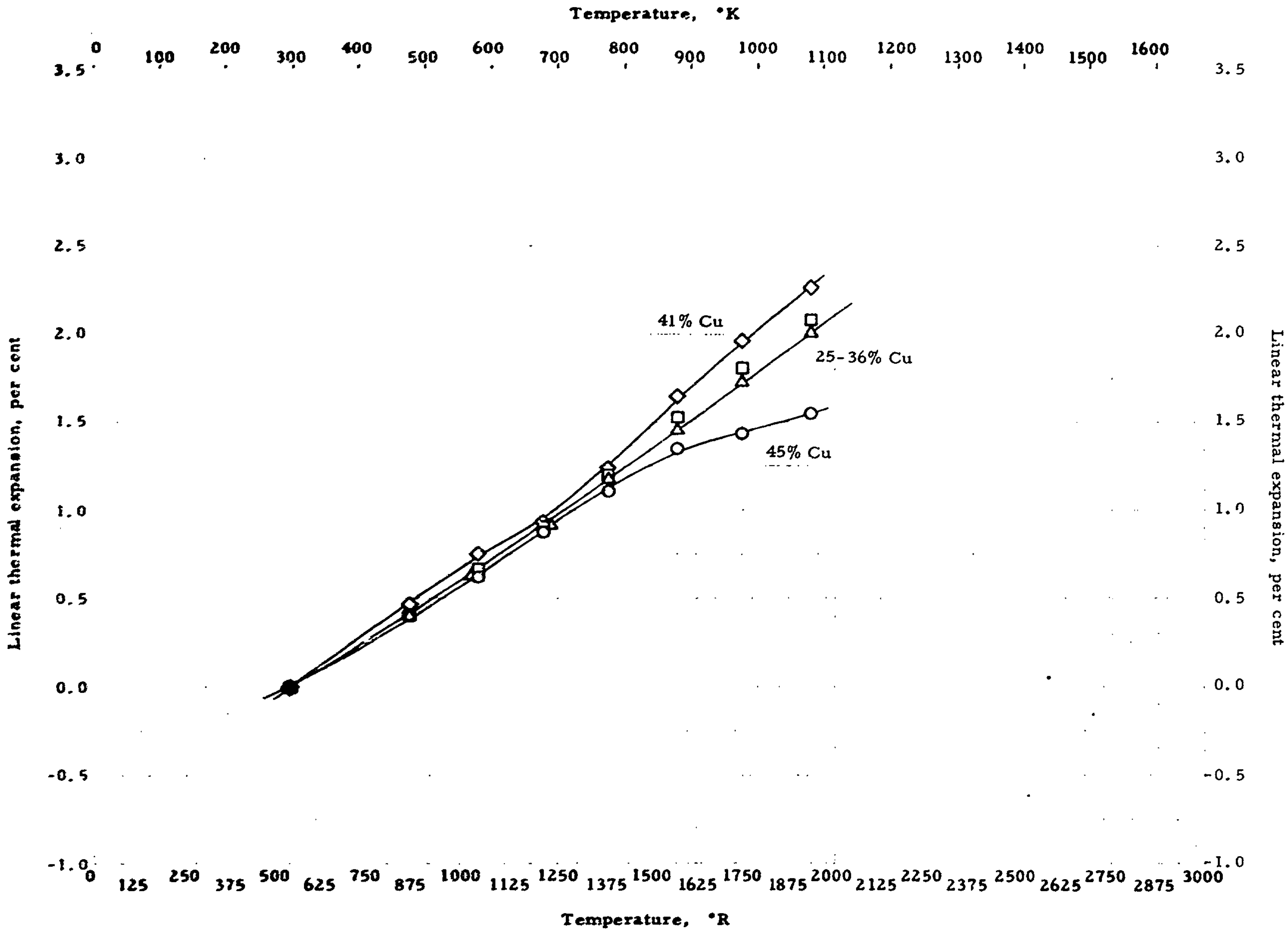


SPECIFIC HEAT -- MANGANESE + COPPER + X

SPECIFIC HEAT -- MANGANESE + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Hira[illegible] K. L	58-22	522-1032	63.1% Mn; 36.9% Cu	Not given	Cooled from 1932°R at 36°R/hr. Auth. also gives data for cooling at 72°R/hr. and 2160°R/hr.
□	Ibid.	58-22	522-1032	Same as above. Face centered cubic α phase, metastable	Same as above	Same values for 2 samples: a) quenched from 1932°R in water at 531°R b) held 300 hr. at 1482°R, cooled to room temperature at 4°R/hr.

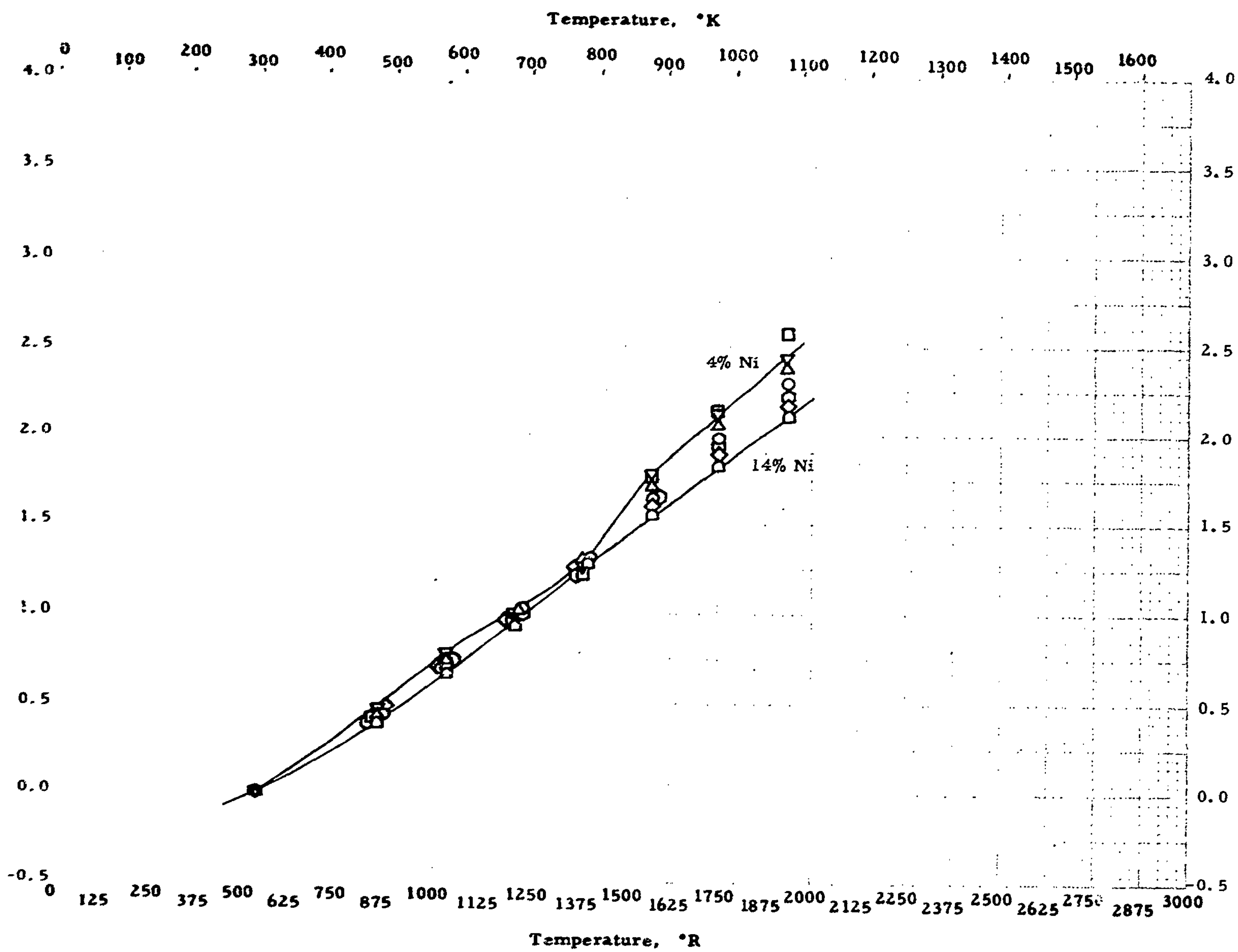


LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(49 - 56% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL (49 - 56% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M. Agladze, R. I. and Topchiashvili, L. I.	55-56	852-1932	49.7% Mn; 45.4% Cu; 4.9% Ni; prepared from electrolytic purity materials	Dilatometer	Quenched, homogenized
◇	Ibid.	55-56	852-1932	53.4% Mn; 41.0% Cu; 5.6% Ni; raw materials same as above	Same as above	Same as above
□	Ibid.	55-56	852-1932	51.5% Mn; 38.6% Cu; 9.9% Ni; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	852-1932	51.6% Mn; 35.8% Cu; 12.6% Ni; also 55.0% Mn; 35.4% Cu; 9.6% Ni; 54.3% Mn; 31.3% Cu; 14.4% Ni; 51.3% Mn; 29.5% Cu; 19.2% Ni; 51.0% Mn; 25.4% Cu; 23.6% Ni; 55.2% Mn; 25.0% Cu; 19.8% Ni	Same as above	Same as above; these six samples gave results which agree within 2%

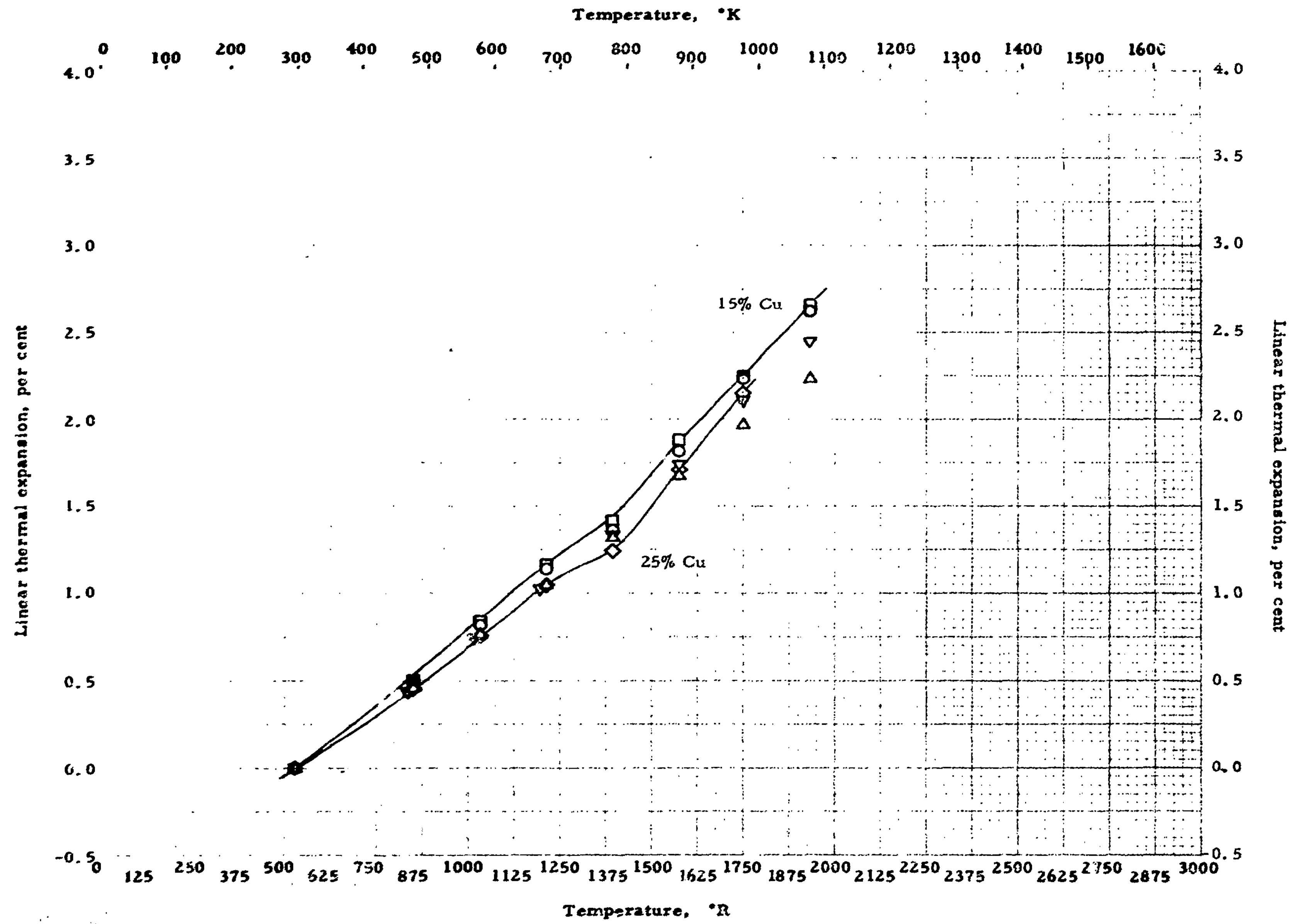


LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(59 - 66% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(59 - 66% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Topchiashvili, L. I.	55-56	528-1932	65.9% Mn; 19.5% Cu; 14.6% Ni; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	65.4% Mn; 29.7% Cu; 4.9% Ni; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	528-1932	65.4% Mn; 24.4% Cu; 10.2% Ni; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	528-1932	59.8% Mn; 21.8% Cu; 18.4% Ni; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	528-1932	59.7% Mn; 36.5% Cu; 3.8% Ni; raw materials same as above	Same as above	Same as above
○	Ibid.	55-56	528-1932	59.7% Mn; 33.5% Cu; 6.8% Ni; raw materials same as above	Same as above	Same as above
□	Ibid.	55-56	528-1932	59.7% Mn; 25.9% Cu; 14.4% Ni; raw materials same as above	Same as above	Same as above

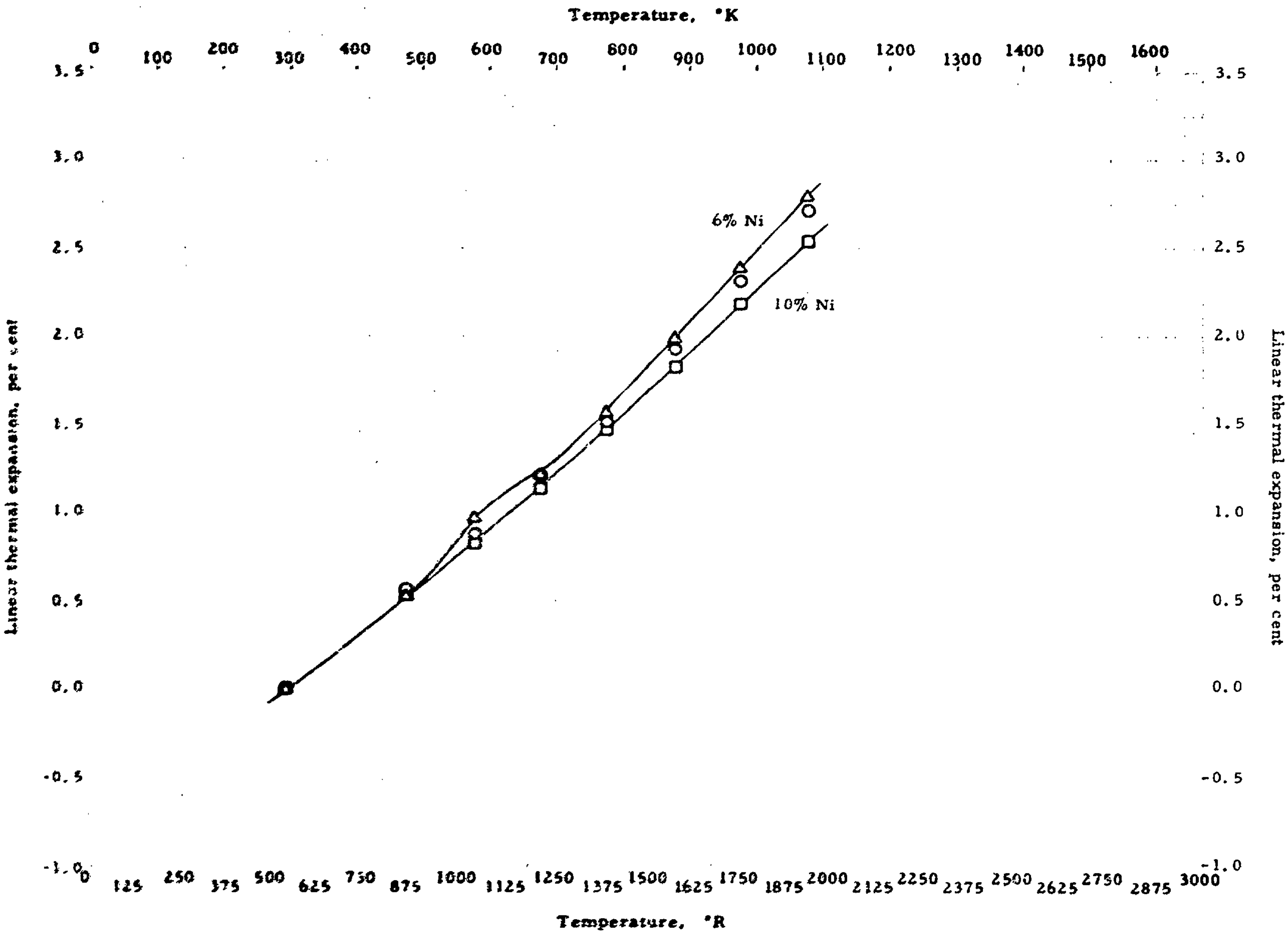


LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(69 - 76% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(69 - 76% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Top-mashvili, L. I.	55-56	528-1932	75.5% Mn; 1[illegible].6% Cu, 5.6% Ni; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	75.3% Mn; 14.6% Cu, 10.1% Ni; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	528-1932	70.9% Mn; 15.3% Cu, 13.8% Ni; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	528-1932	70.7% Mn; 24.6% Cu; 9.7% Ni; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	528-1932	69.6% Mn, 20.1% Cu; 10.3% Ni; raw materials same as above	Same as above	Same as above

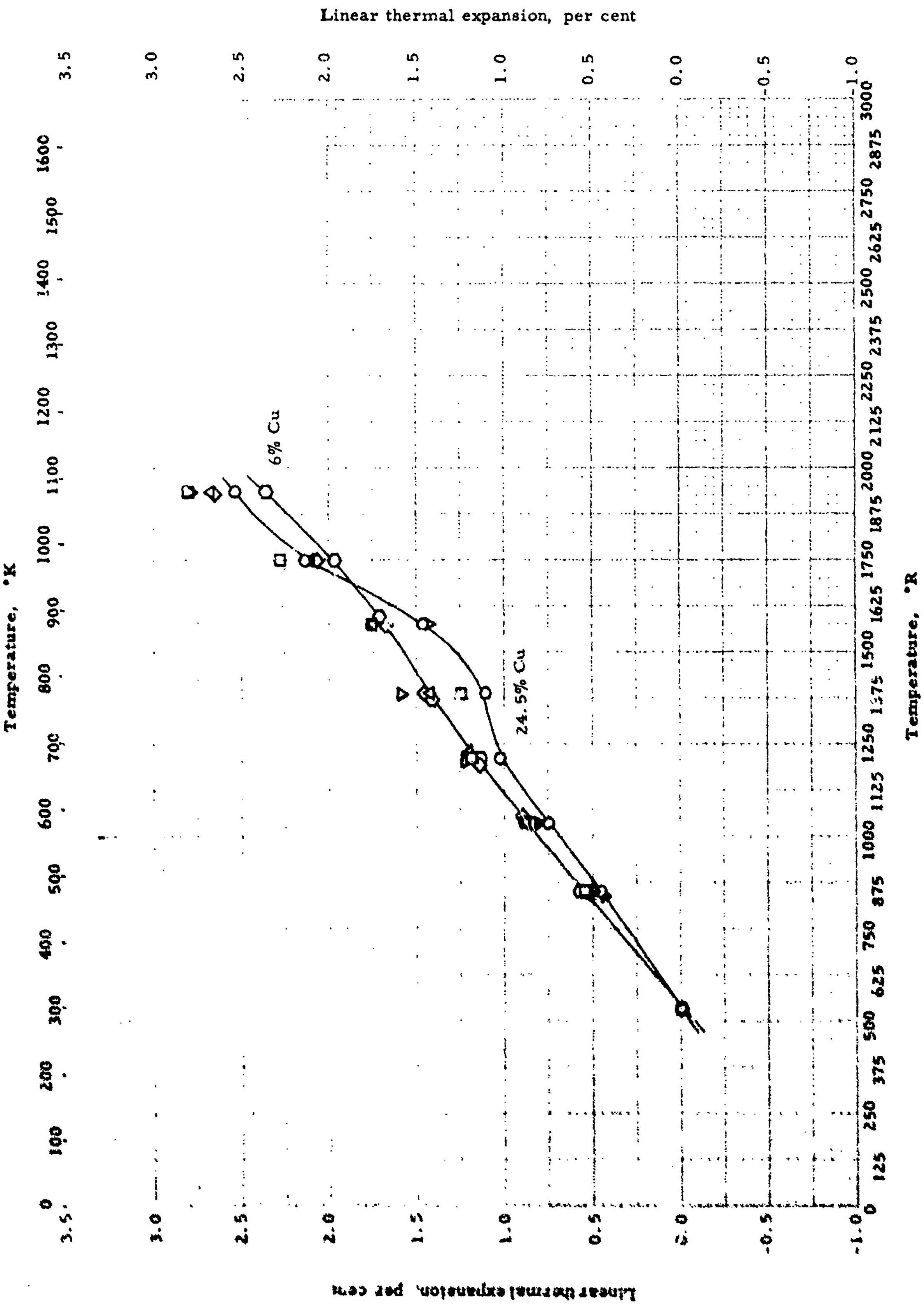


LINEAR THERMAL EXPANSION - MANGANESE + COPPER + NICKEL
(79 - 84% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER + NICKEL
(79 - 84% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Topchiashvili, L. I.	55-56	852-1932	79.2% Mn; 15.0% Cu; 5.8% Ni; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	852-1932	79.8% Mn; 10.2% Cu; 10.0% Ni; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	852-1932	83.4% Mn; 10.7% Cu; 5.9% Ni; raw materials same as above	Same as above	Same as above

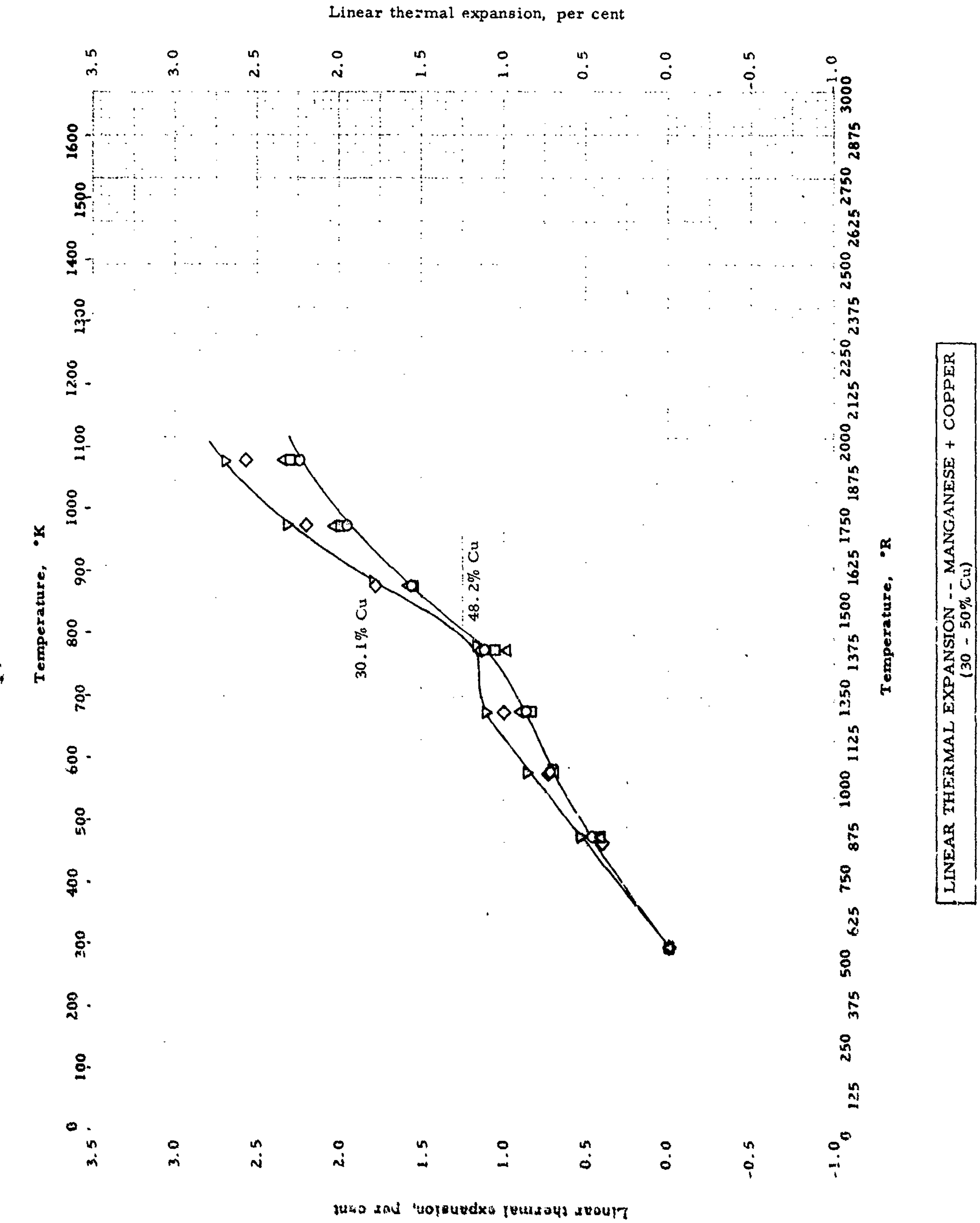


LINEAR THERMAL EXPANSION -- MANGANESE + COPPER
(5 - 25% Cu)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER
(5 - 25% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °K	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Topchiashvili, L. I.	55-56	852-1932	75.5% Mn; 24.5% Cu; raw materials same as above	Same as above	Same as above
□	Ibid.	55-56	852-1932	79.4% Mn; 20.1% Cu; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	852-1932	83.7% Mn; 15.6% Cu; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	852-1932	88.5% Mn; 10.5% Cu; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	852-1932	93.9% Mn; 5.6% Cu; raw materials same as above	Same as above	Same as above
○	Ibid.	55-56	852-1932	94.0% Mn; 6.0% Cu; raw materials same as above	Same as above	Same as above

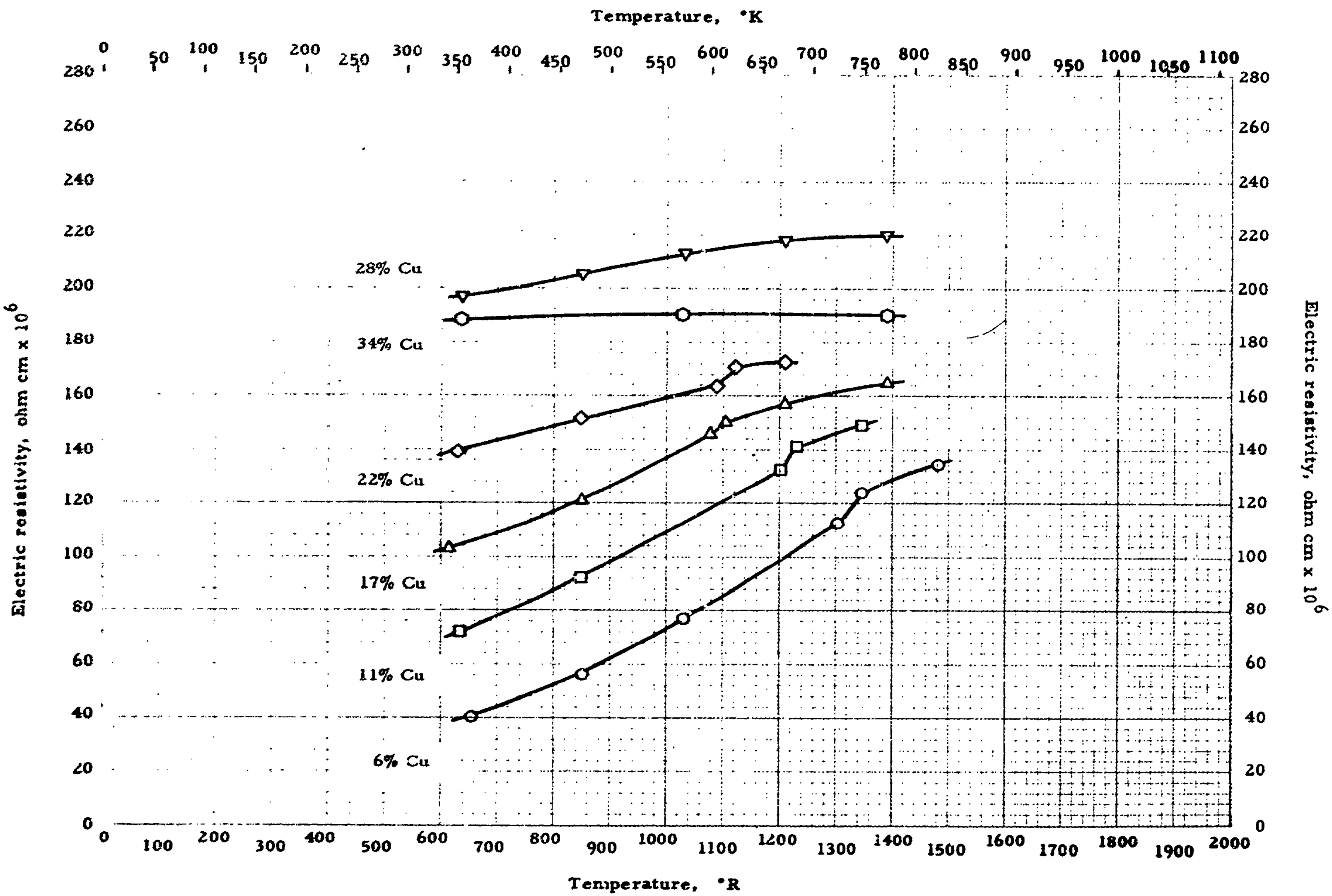


LINEAR THERMAL EXPANSION -- MANGANESE + COPPER
(30 - 50% Cu)

LINEAR THERMAL EXPANSION -- MANGANESE + COPPER (30 - 50% Cu)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V.M., Agladze, R.I. and Topchiashvili, L.I.	55-56	852-1932	51.6% Mn; 48.2% Cu; prepared from electrolytic purity raw materials	Dilatometer	Quenched, annealed
□	Ibid.	55-56	852-1932	53.4% Mn; 45.7% Cu; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	852-1932	58.6% Mn; 41.4% Cu; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	852-1932	65.0% Mn; 35% Cu; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	852-1932	69.9% Mn; 30.1% Cu; raw materials same as above	Same as above	Same as above

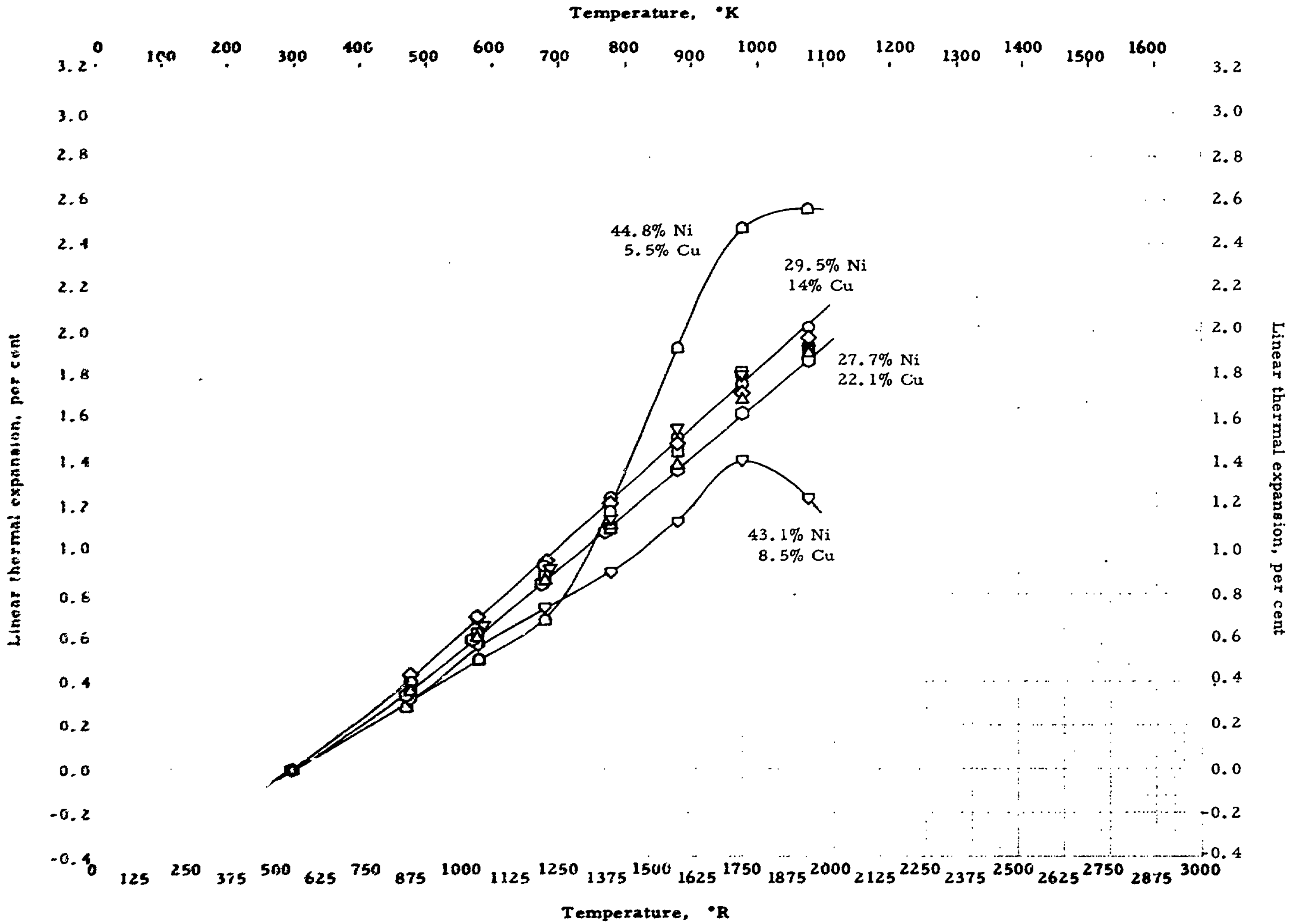


ELECTRIC RESISTIVITY -- MANGANESE + COPPER

ELECTRIC RESISTIVITY -- MANGANESE + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bacon, G. E., Dunmur, L.W. et al.	57-157	654-1482	94.26% Mn; 5.74% Cu	Potential drop	
□	Ibid.	57-157	636-1347	88.61% Mn; 11.39% Cu	Same as above	
△	Ibid.	57-157	618-1392	83.05% Mn; 16.95% Cu	Same as above	
◇	Ibid.	57-157	627-1212	77.57% Mn; 22.43% Cu	Same as above	
▽	Ibid.	57-157	636-1392	72.17% Mn; 27.83% Cu	Same as above	
○	Ibid.	57-157	636-1392	65.8% Mn; 34.20% Cu	Same as above	

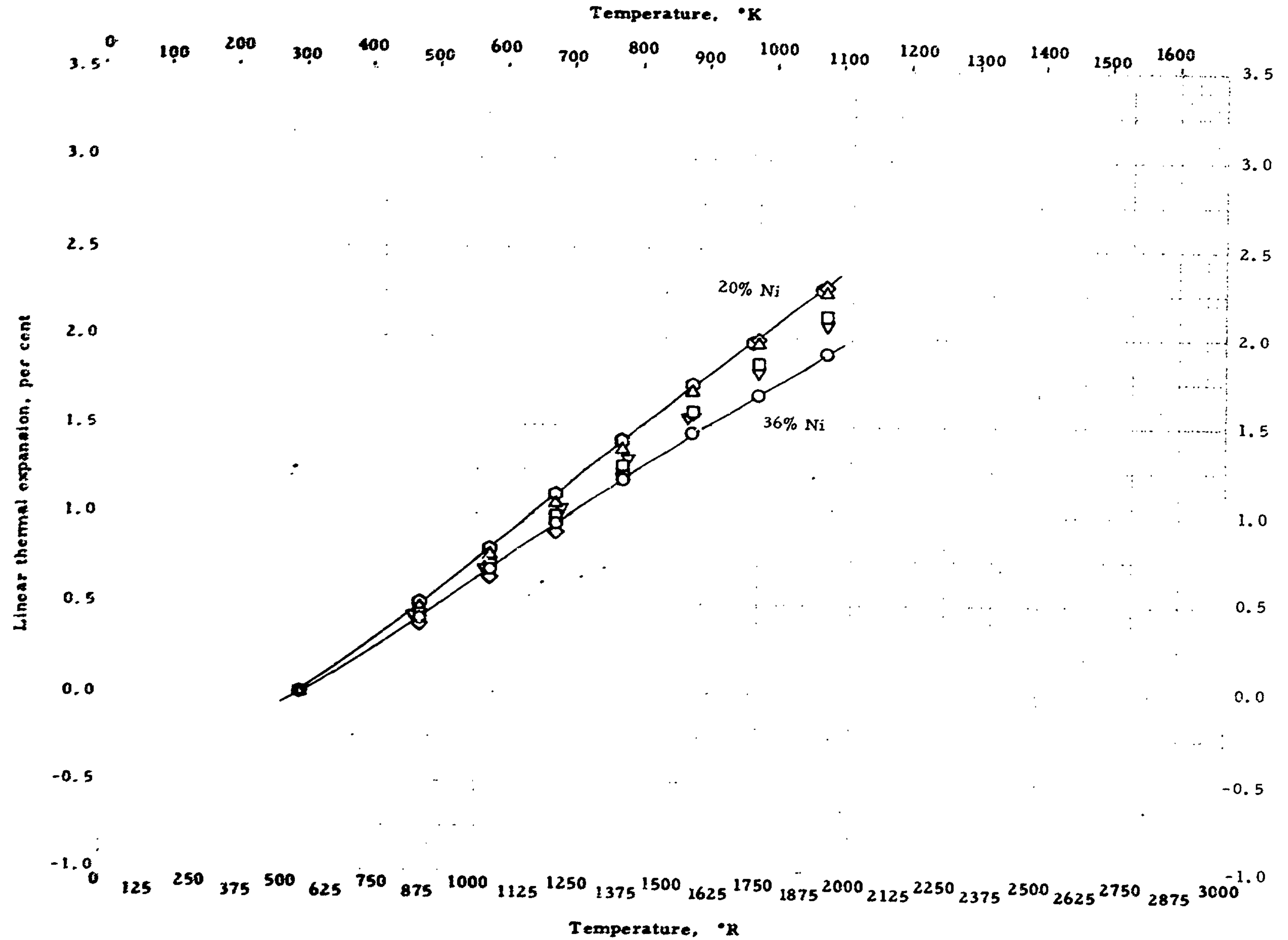


LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(48 - 57% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER (48 - 57% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. J. and Topchiashvili, L. I.	55-56	528-1932	56.5% Mn; 29.5% Ni; 14% Cu; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	55.0% Mn; 39.5% Ni; 5.5% Cu; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	528-1932	54.5% Mn; 35.0% Ni; 10.5% Cu; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	528-1932	54.2% Mn; 27.7% Ni, 21.1% Cu; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	528-1932	51.9% Mn; 35.7% Ni; 12.4% Cu; raw materials same as above	Same as above	Same as above
○	Ibid.	55-56	528-1932	51.1% Mn; 27.7% Ni; 22.1% Cu; raw materials same as above	Same as above	Same as above
◒	Ibid.	55-56	528-1932	49.7% Mn; 44.8% Ni; 5.5% Cu; raw materials same as above	Same as above	Same as above
◓	Ibid.	55-56	528-1932	48.4% Mn; 43.1% Ni; 8.5% Cu; raw materials same as above	Same as above	Same as above

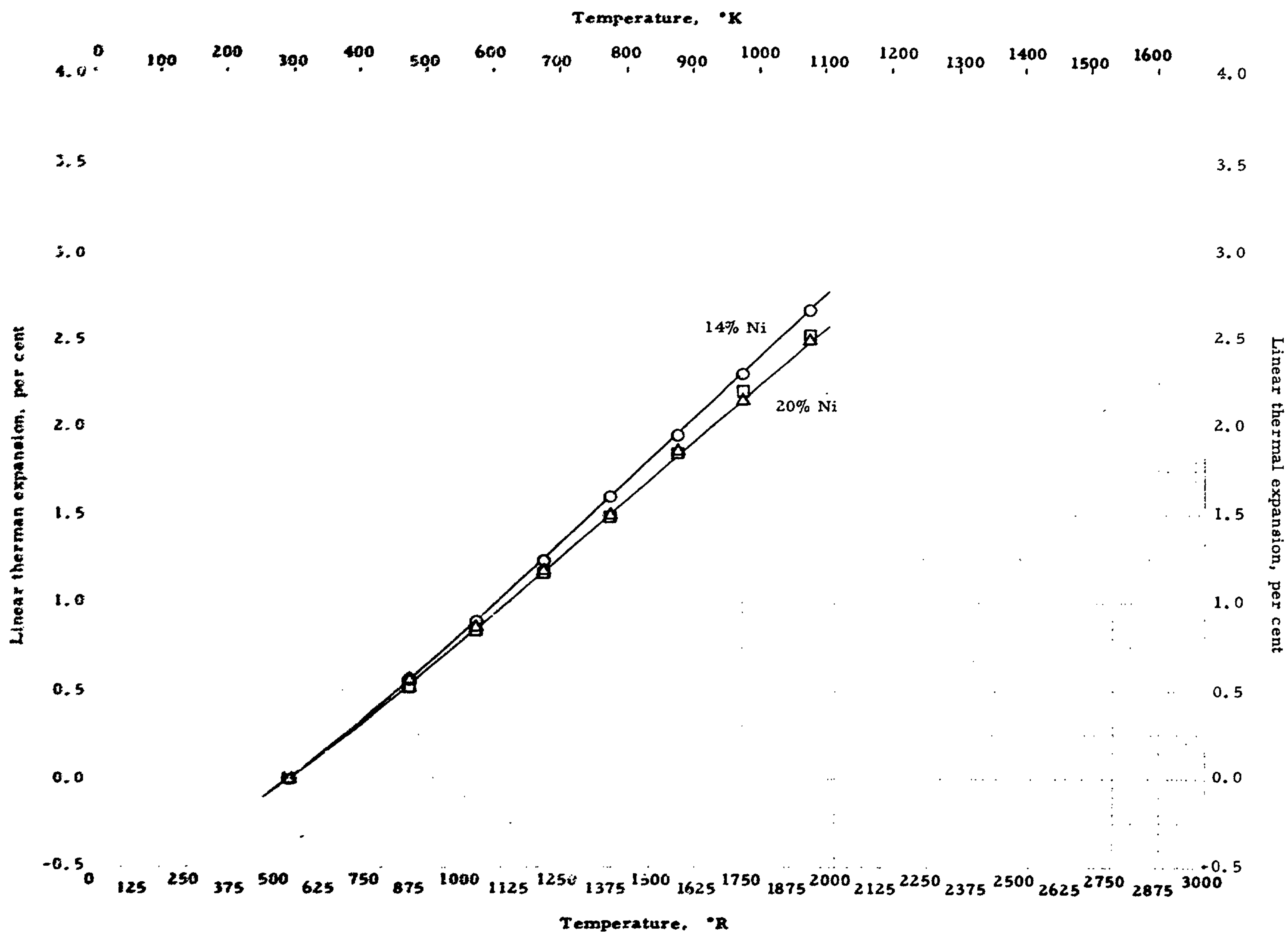


LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(59 - 70% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(59 - 70% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Topchiashvili, L. I.	55-56	852-1932	59.6% Mn; 36.2% Ni; 4.2% Cu; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	852-1932	59.3% Mn; 30.3% Ni; 10.4% Cu; also: 60.0% Mn; 24.4% Ni; 15.6% Cu; raw materials same as above	Same as above	Same as above; results agree within 2%
△	Ibid.	55-56	852-1932	64.4% Mn; 24.7% Ni; 10.9% Cu; raw materials same as above	Same as above	Quenched, homogenized
◇	Ibid.	55-56	852-1932	64.6% Mn; 20.4% Ni; 15% Cu; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	852-1932	64.8% Mn; 30.0% Ni; 5.2% Cu; raw materials same as above	Same as above	Same as above
○	Ibid.	55-56	852-1932	69.5% Mn; 20.5% Ni; 10% Cu; also: 69.6% Mn; 24.6% Ni; 5.8% Cu; raw materials same as above	Same as above	Same as above; results agree within 2%

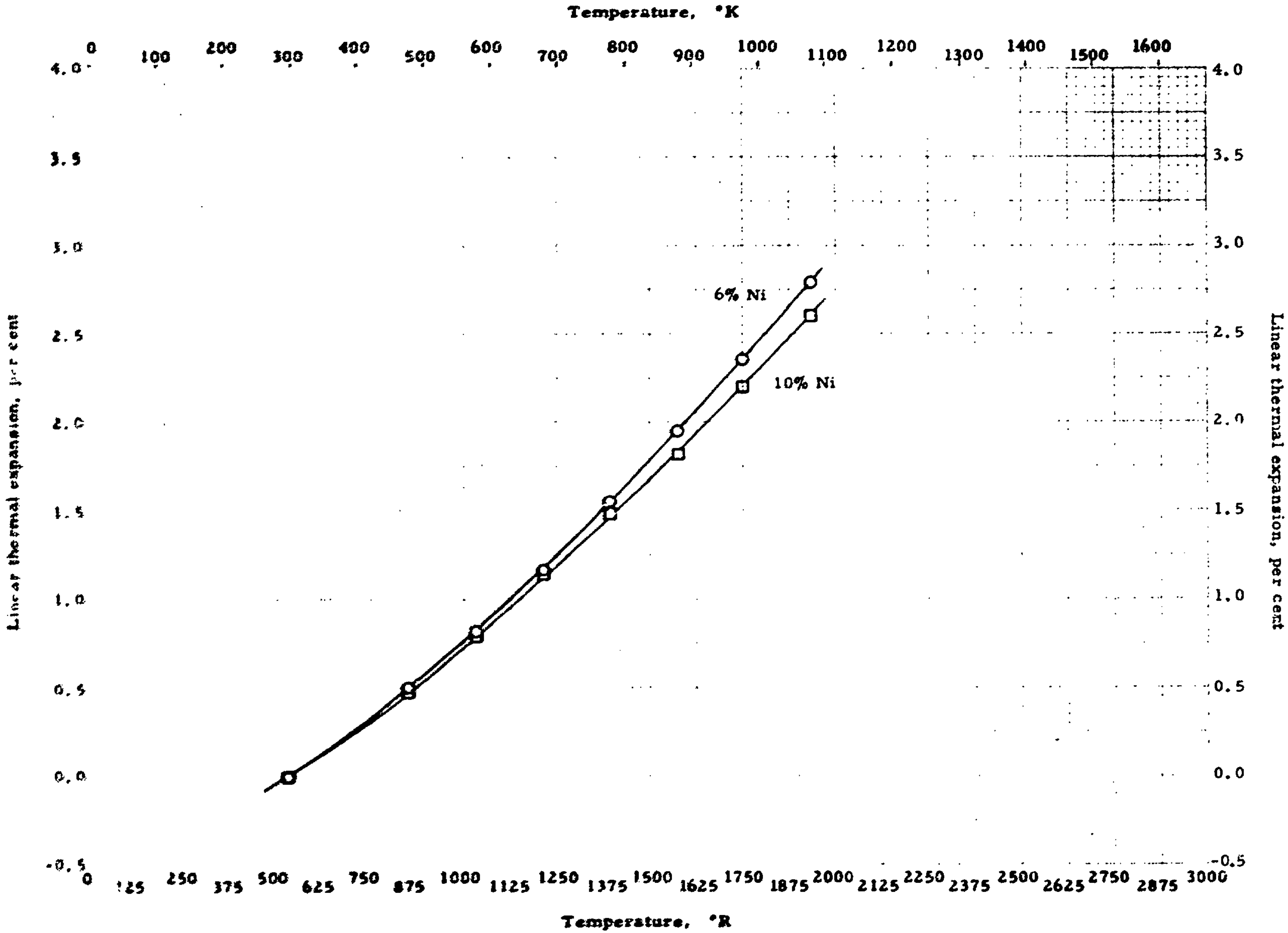


LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(75 - 80% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER (75 - 80% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. J. and Topchiashvili, L. I.	55-56	528-1932	79.5% Mn; 14.3% Ni; 6.2% Cu; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	75.2% Mn; 15.3% Ni; 9.5% Cu; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	528-1932	75.1% Mn; 20.1% Ni; 4.8% Cu; raw materials same as above	Same as above	Same as above

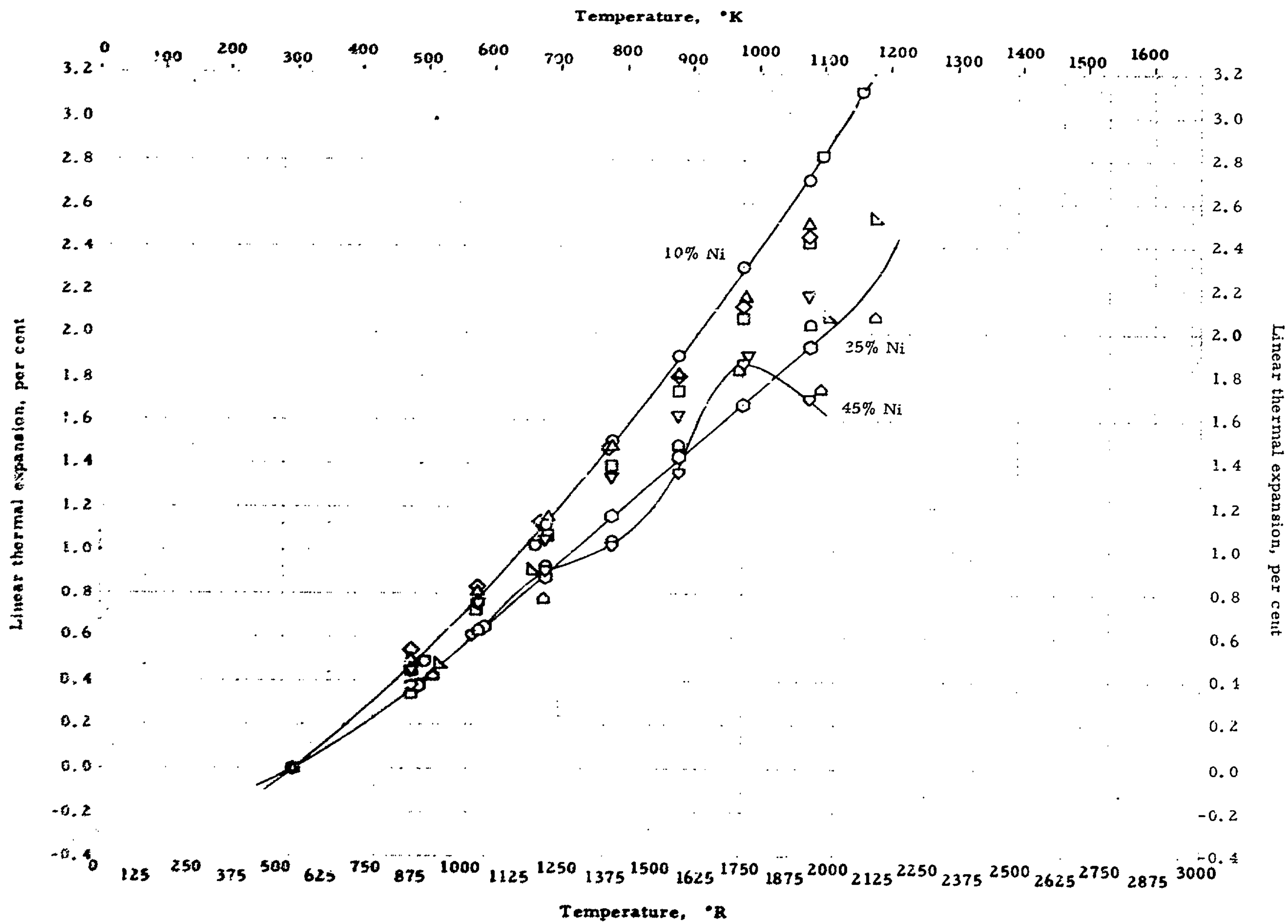


LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(84 - 89% Mn)

LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL + COPPER
(84 - 89% Mn)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Mokhov, V. M., Agladze, R. I. and Topchiashvili, L. I.	55-56	528-1932	88.1% Mn; 6.0% Ni; 5.9% Cu; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	84.6% Mn; 10.2% Ni; 5.2% Cu; raw materials same as above	Same as above	Same as above

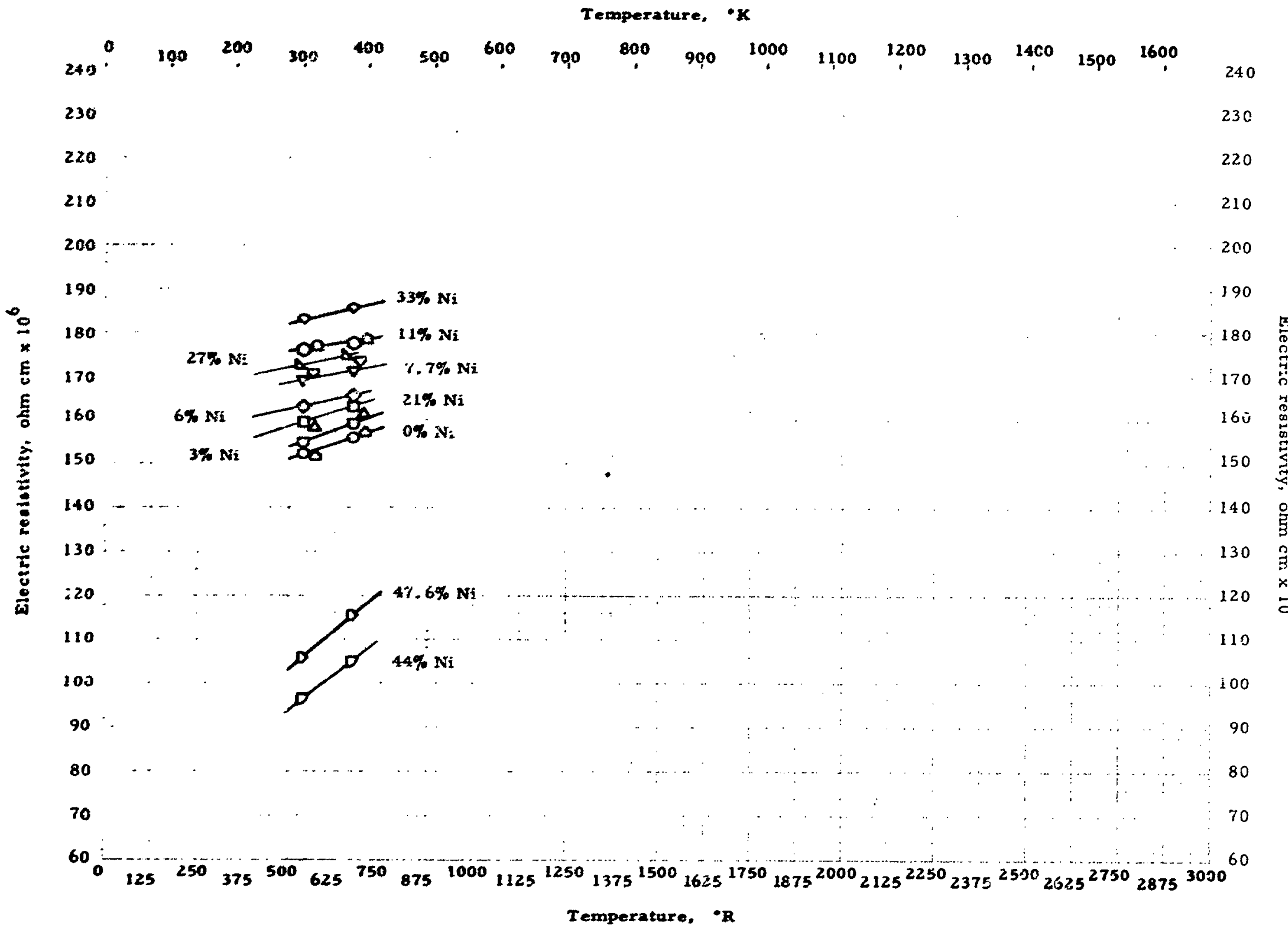


LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL

LINEAR THERMAL EXPANSION -- MANGANESE + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Mokhov, V. M., Agladze, R. I. and Tupchiashvili, L. I.	55-56	528-1932	89.7% Mn; 10.3% Ni; prepared from electrolytic purity raw materials	Dilatometer	Quenched, homogenized
□	Ibid.	55-56	528-1932	84.0% Mn; 16.0% Ni; raw materials same as above	Same as above	Same as above
△	Ibid.	55-56	528-1932	79.8% Mn; 20.2% Ni; raw materials same as above	Same as above	Same as above
◇	Ibid.	55-56	528-1932	75.1% Mn; 24.9% Ni; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	528-1932	70.1% Mn; 29.9% Ni; raw materials same as above	Same as above	Same as above
○	Ibid.	55-56	528-1932	65.4% Mn; 34.6% Ni; raw materials same as above	Same as above	Same as above
□	Ibid.	55-56	528-1932	59.3% Mn; 40.7% Ni; raw materials same as above	Same as above	Same as above
▽	Ibid.	55-56	528-1932	54.8% Mn; 45.2% Ni; raw materials same as above	Same as above	Same as above
○	Kurnakov, N. N. and Troneva, M. Ya.	49-32	852-2112	89.21% Mn; 10.79% Ni	Dilatometer with visual reading	Prepared from electrolytic Mn and Ni in alumina crucibles in an induction furnace
△	Ibid.	49-32	832-2112	67.31% Mn, 32.69% Ni	Same as above	Same as above
◇	Ibid.	49-32	832-2112	57.05% Mn; 42.95% Ni	Same as above	Same as above

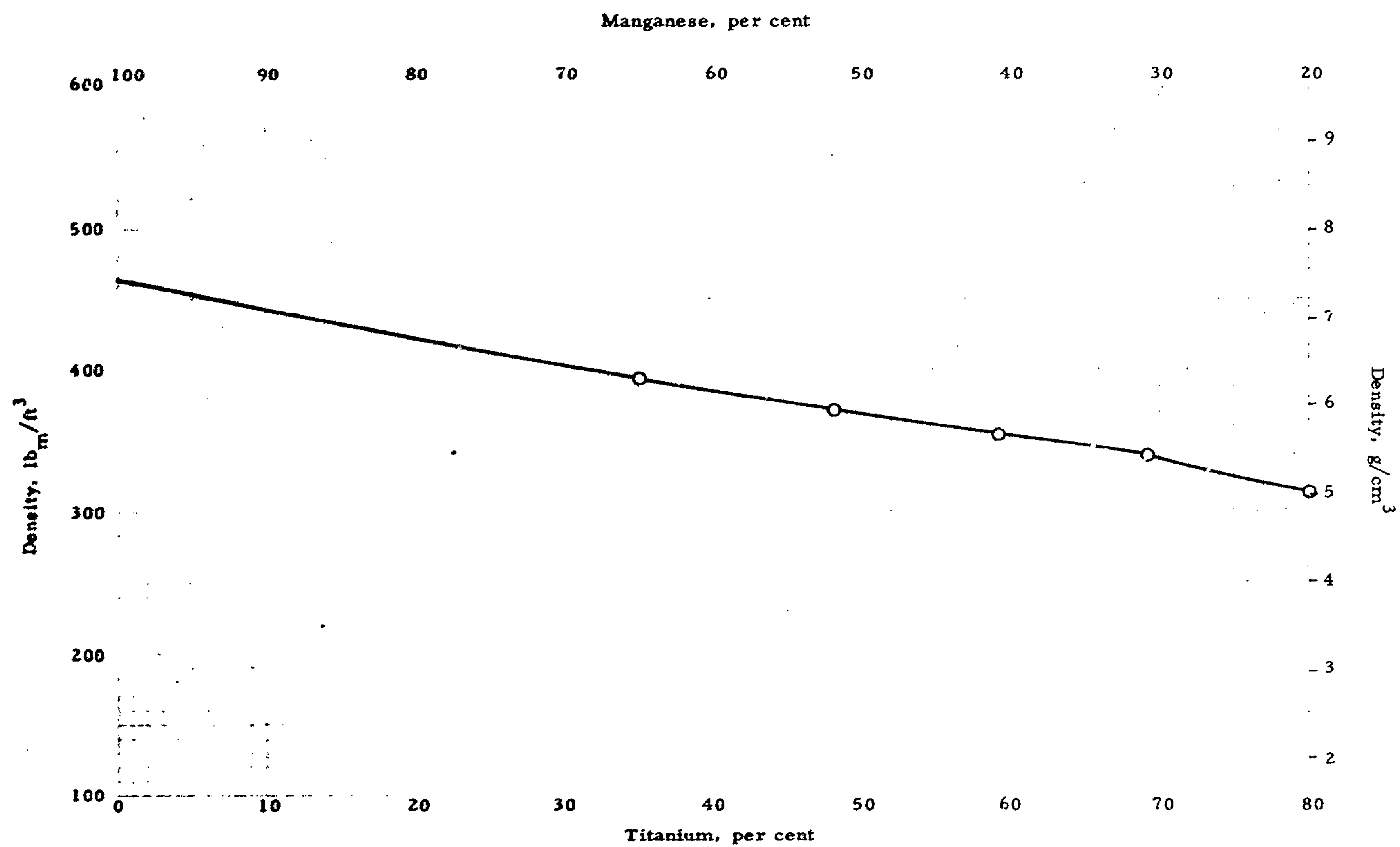


ELECTRIC RESISTIVITY -- MANGANESE + NICKEL

ELECTRIC RESISTIVITY -- MANGANESE + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref	Range, °R	Material Composition	Test Method	Remarks
○	Kurnakov, N. N. and Troneva, M. Ya.	49-32	537-672	0.0% Ni	Kelvin double Bridge	Sample annealed in steps from 980°C to 500°C, the entire process lasting 5 days
□	Ibid.	49-32	537-672	3.23% Ni	Same as above	Same as above
△	Ibid.	49-32	537-672	3.51% Ni	Same as above	Same as above
◇	Ibid.	49-32	537-672	6.04% Ni	Same as above	Same as above
▽	Ibid.	49-32	537-672	7.74% Ni	Same as above	Same as above
○	Ibid.	49-32	537-672	10.79% Ni	Same as above	Same as above
□	Ibid.	49-32	537-672	11.75% Ni	Same as above	Same as above
△	Ibid.	49-32	537-672	15.75% Ni	Same as above	Same as above
□	Ibid.	49-32	537-672	20.98% Ni	Same as above	Same as above
▽	Ibid.	49-32	537-672	26.32% Ni	Same as above	Same as above
△	Ibid.	49-32	537-672	26.98% Ni	Same as above	Same as above
◇	Ibid.	49-32	537-672	32.69% Ni	Same as above	Same as above
▽	Ibid.	49-32	537-672	43.94% Ni	Same as above	Same as above
▷	Ibid.	49-32	537-672	47.60% Ni	Same as above	Same as above



DENSITY -- MANGANESE + TITANIUM

DENSITY -- MANGANESE + TITANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Maykuth, D. J., Ogden, H. R. et al.	54-57	Room	Alloy Series 35-80% Ti	ρ: weight in air and in water	Also see Ti + Mn alloys

PROPERTIES OF URANIUM + CHROMIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 5.6% Cr . . .	1097 lb_m/ft^3	17.57 g/cm^3
Melting Point 5.6% Cr .	2040 °R	1130 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	○	1089	17.44
	□	1087	17.41
	△	1077	17.25
	◇	1097	17.57
	▽	1078	17.26
	⬡	1096	17.56
	⌂	1080	17.3

		°R	°K
Melting Point:			
	△	2038 ± 20	1132 ± 10

	Btu/lb_m	cal/g
Heat of Fusion:		

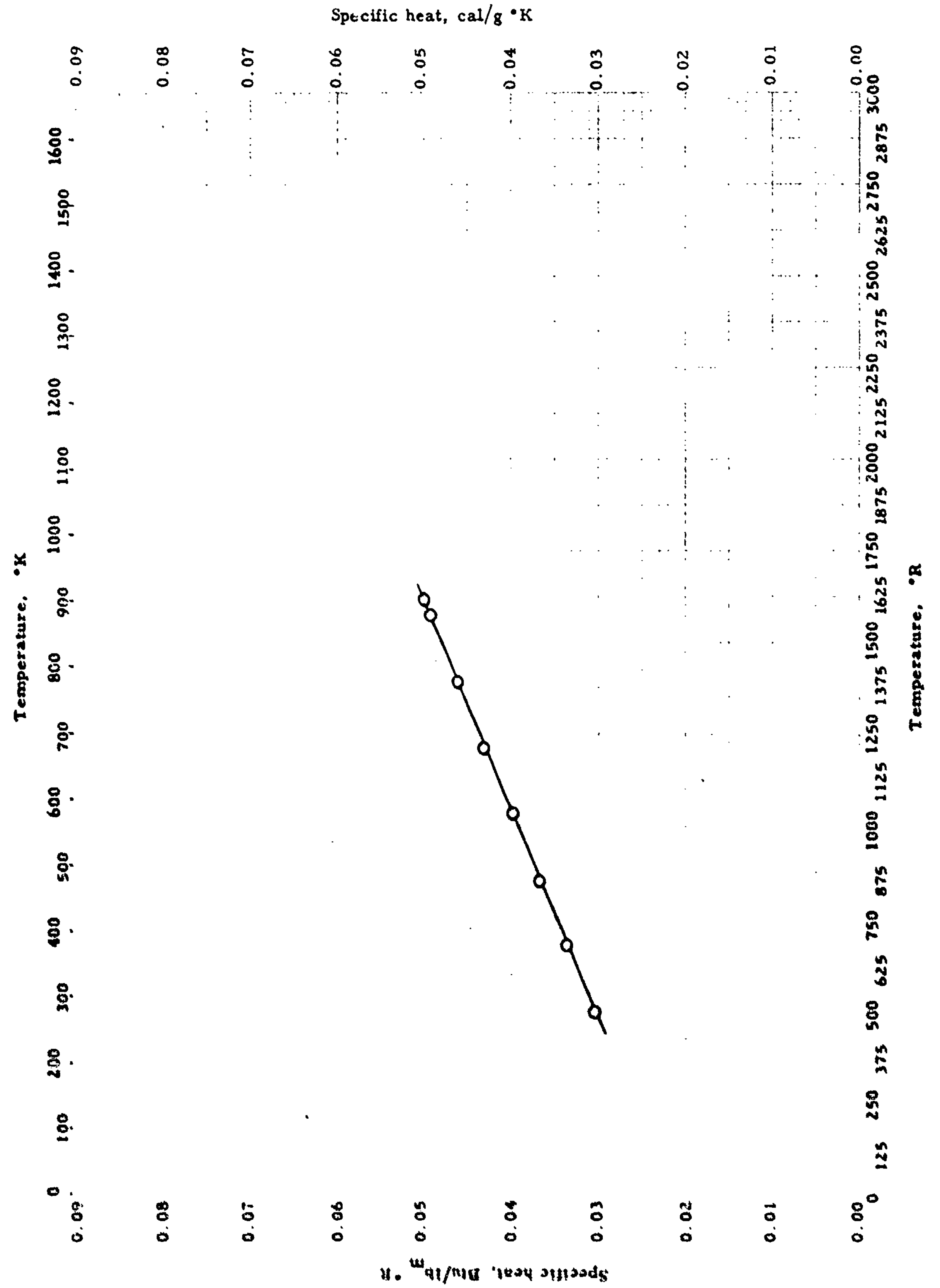
	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF URANIUM + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A., Hough, F. A. and Dickerson, R.	53-56	Room	5.27% Cr	ρ: not given	
□	Ibid.	53-56	Room	5.42% Cr	ρ: same as above	
△	Ibid.	53-56	Room 2038 ± 20	5.60% Cr	ρ: same as above MP: not given	
◇	Ibid.	53-56	Room	5.60% Cr	ρ: same as above	
▽	Ibid.	53-56	Room	5.92% Cr	ρ: same as above	
○	Ibid.	53-56	Room	5% Cr	ρ: same as above	
◘	Massachusetts Inst. of Technology	53-126	Room	5.1% Cr; 0.125% C	ρ: weight in air and volume by water displacement in graduated cylinder	Vacuum cast at 5 - 35μ Hg. Meas. by Paynton, W. C. and Sawyer, H. F.

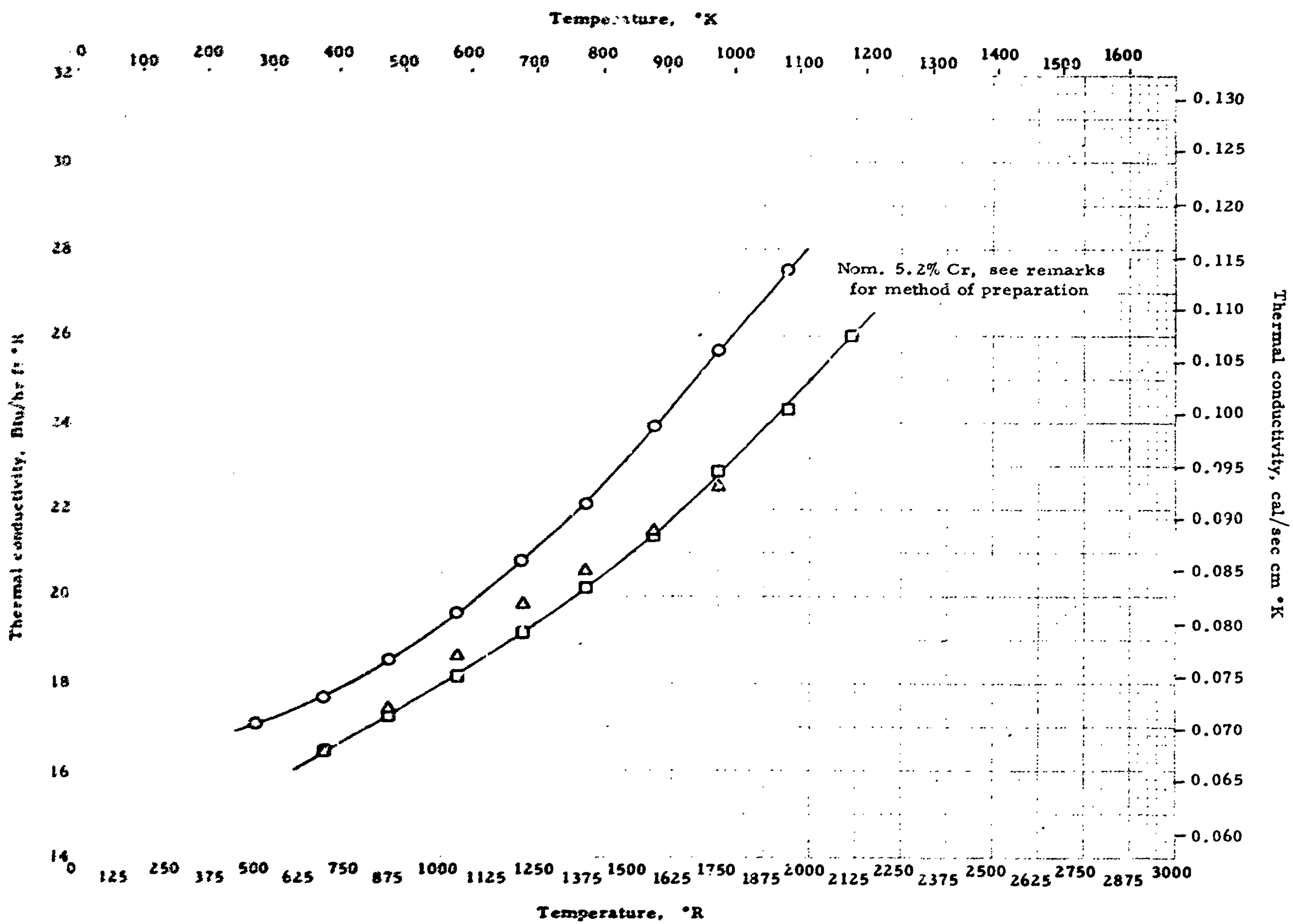


SPECIFIC HEAT -- URANIUM + CHROMIUM

SPECIFIC HEAT -- URANIUM + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Saller, H. A., Rough, F. A. and Dickerson, R.	53-56	492-1617	5.6% Cr	Drop method ice calorimeter	

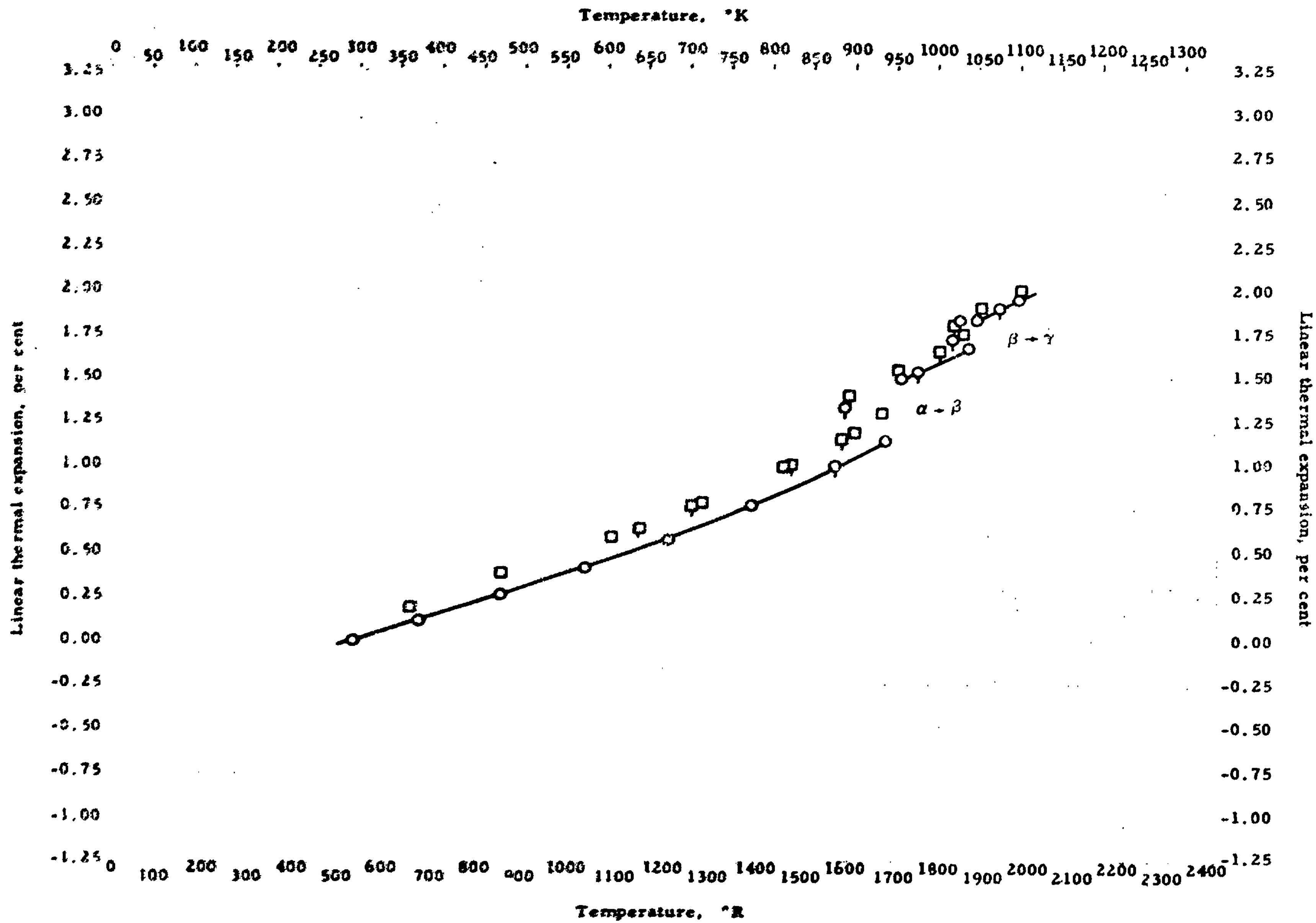


THERMAL CONDUCTIVITY -- URANIUM + CHROMIUM + X

THERMAL CONDUCTIVITY -- URANIUM + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W., Winn, R. A. and Lucks, C. F.	54-42	492-1932	Nominal 5.2% Cr	Comparative; rods	Biscuit uranium cast in cold graphite; avg. of 2 samples within 3%
□	Ibid.	54-42	672-2112	Same as above	Same as above	Biscuit uranium cast in warm graphite; avg. of 2 samples within 4%
△	Ibid.	54-42	672-1752	Same as above	Same as above	Biscuit uranium cast in copper

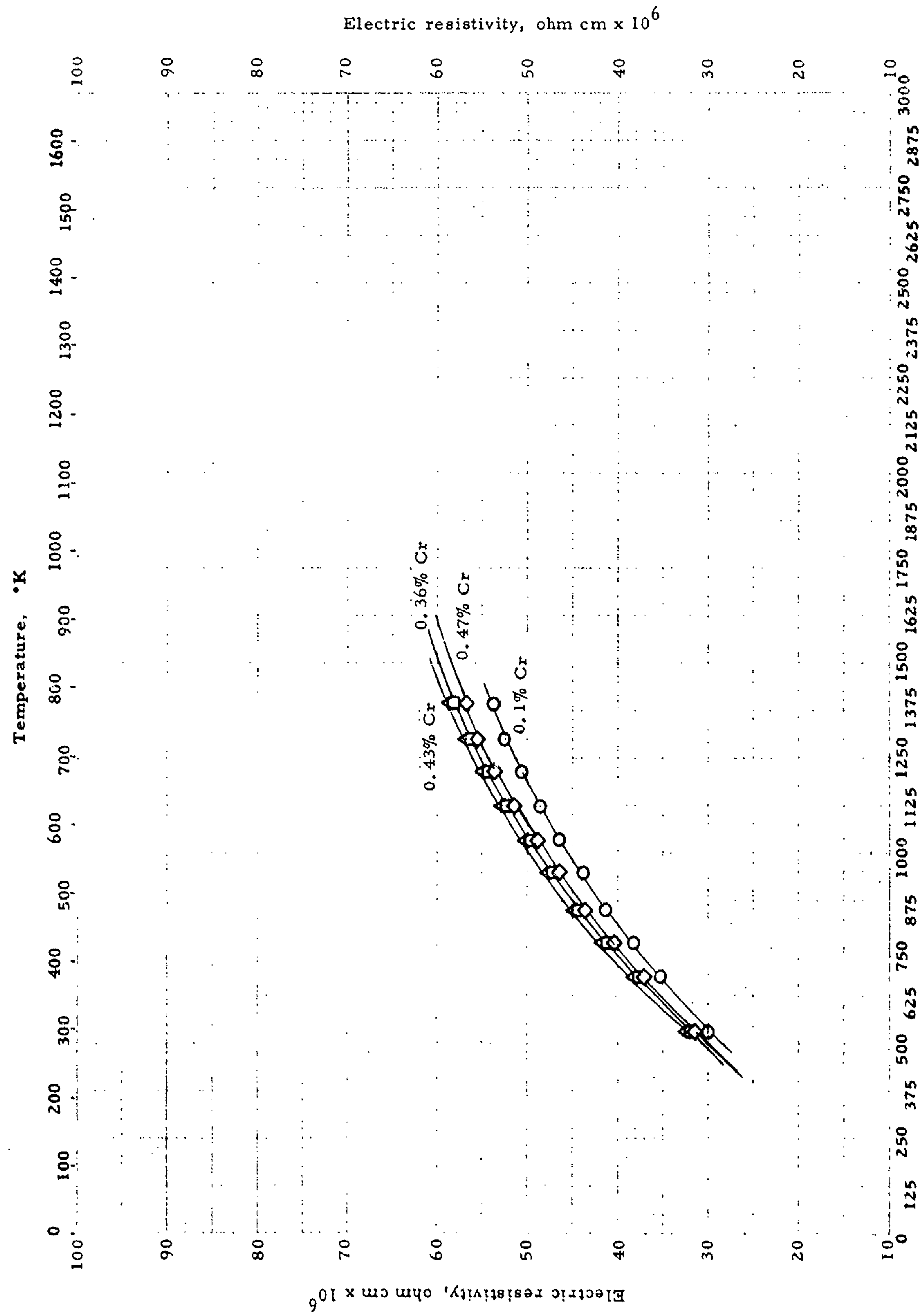


LINEAR THERMAL EXPANSION -- URANIUM + CHROMIUM

LINEAR THERMAL EXPANSION -- URANIUM + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Deem, H. W., Winn, R. A. and Lucks, C. F.	54-42	528-1968	Eutectic Alloy - nominally 5.2% Cr	Quartz tube dilatometer	12 samples. Induction melted and formed in various ways. Effect of method of forming is insignificant. ○ -heating, ♀ -cooling (3°C/min. maximum); below 1572°R, results are same
□	Massachusetts Inst. of Technology	53-126	627-1845	5.1% Cr; 0.0250% C	Quartz tube dilatometer with differential transformer pickup, tested in argon atm.	Measured by Paynton W. C. and Sawyer, H. F. Vacuum cast 5 - 35 μ Hg □ - heating ☐ - cooling

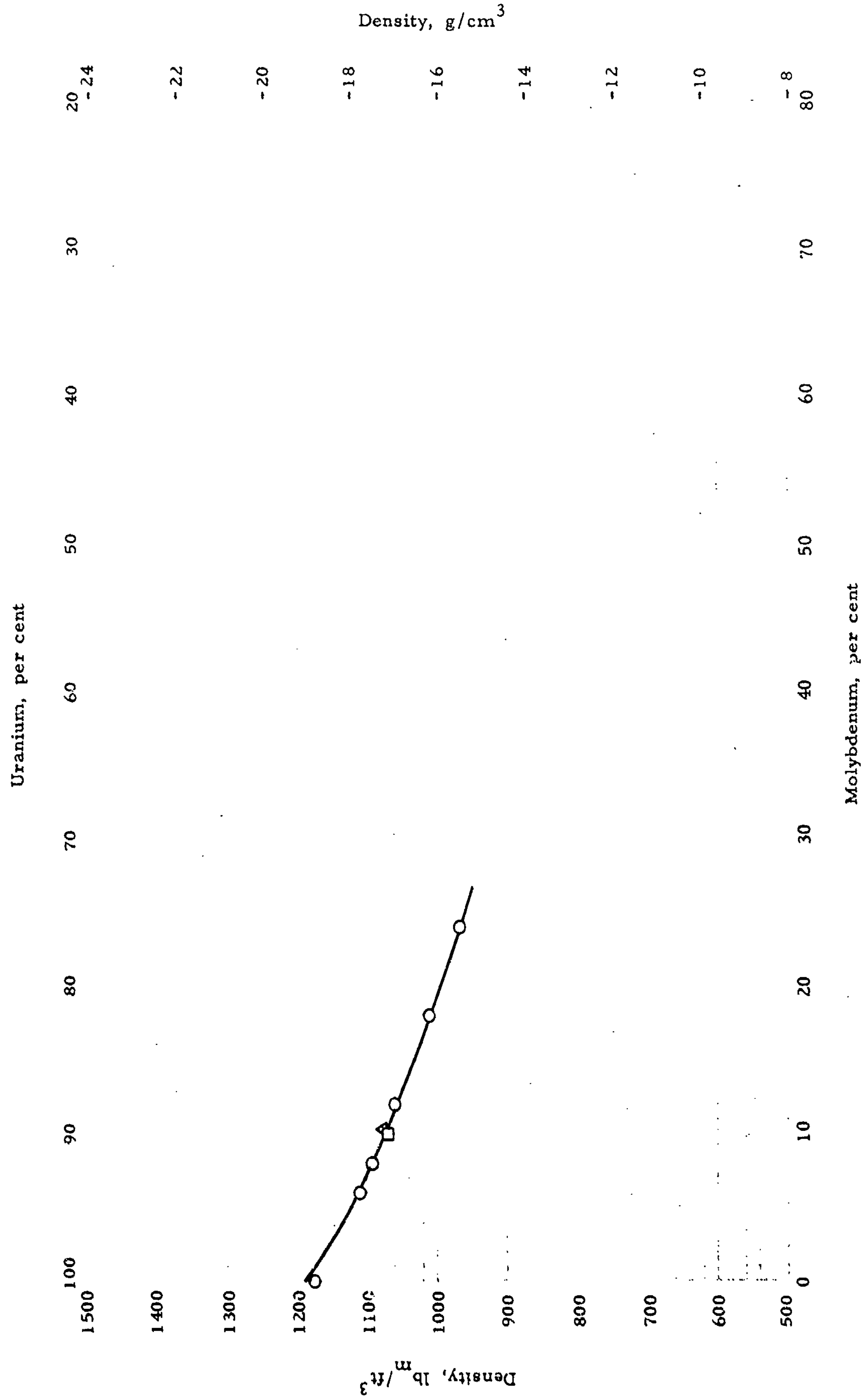


ELECTRIC RESISTIVITY -- URANIUM + CHROMIUM + X

ELECTRIC RESISTIVITY -- URANIUM + CHROMIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A. and Rough, F. A.	55-23	528-1392	0.1% Cr; < 0.01% C	Potential drop	Heated 15 min. at 715 ± 10°C; quenched to 575 ± 10°C, held 15 min.; water quenched, reheated 15 min. at 715 ± 10°C; quenched to 575 ± 10°C, held 20 min.; water quenched
□	Ibid.	55-23	528-1392	0.36% C; 0.11% Cr	Same as above	Same as above
△	Ibid.	55-23	528-1392	0.43% Cr; < 0.01% C	Same as above	Heated 15 min. at 715 ± 10°C; quenched to 575 ± 10°C, held 25 min.; water quenched, reheated 15 min. at 715 ± 10°C; quenched to 500 ± 10°C, held 90 min.; water quenched
◇	Ibid.	55-23	528-1392	0.47% Cr; 0.08% C	Same as above	Same as above



DENSITY -- URANIUM + MOLYBDENUM

DENSITY -- URANIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bostrom, W.A., Burkart, M.W., Halteman, E.K. et al	55-111	Room	0 - 24% Mo	Weight in air and CCl_4	Author estimated accuracy 0.04%. Quenched from 900° C
□	Del Grosso, A.	57-155	Room	90% U; 10% Mo	Not given	Metastable γ-phase - Measured at Southern Research Institute
△	Ibid	57-155	Room	90% U; 10% Mo	Same as above	Fully transformed stable phase (γ + ε) Measured at Southern Research Institute

PROPERTIES OF URANIUM + MOLYBDENUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 95% U . .	2300 °R	1280 °K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
Melting Point:		°R	°K
	○	2296	1276
	□	2292	1273
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF URANIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Dayton, R. W. and Tipton, C. R.	56-118	2296	Fissium Alloy, nominal: 95% U; 2.46% Mo; 1.96% Ru; 0.28% Rh; 0.03% others	MP: melted in graphite mold in vacuum	
□	Argonne Natl. Laboratory	57-114	2292	99.5% U; 0.246% Mo; 0.196% Ru; 0.028% Rh; 0.03% others	MP: not given	Contains 10% fissium

PROFERTIES OF URANIUM + MOLYBDENUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 10% Mo . . .	1080 lb_m/ft^3	17.3 g/cm^3
Melting Point 12% Mo .	2560°R	1420°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3
○	1061	17.0
□	1069 ± 1	17.12 ± 0.02
△	1080	17.3
◇	1053 ± 7	16.86 ± 0.12

Melting Point:

	°R	°K
○	2561	1423

Heat of Fusion: Btu/lb_m cal/g

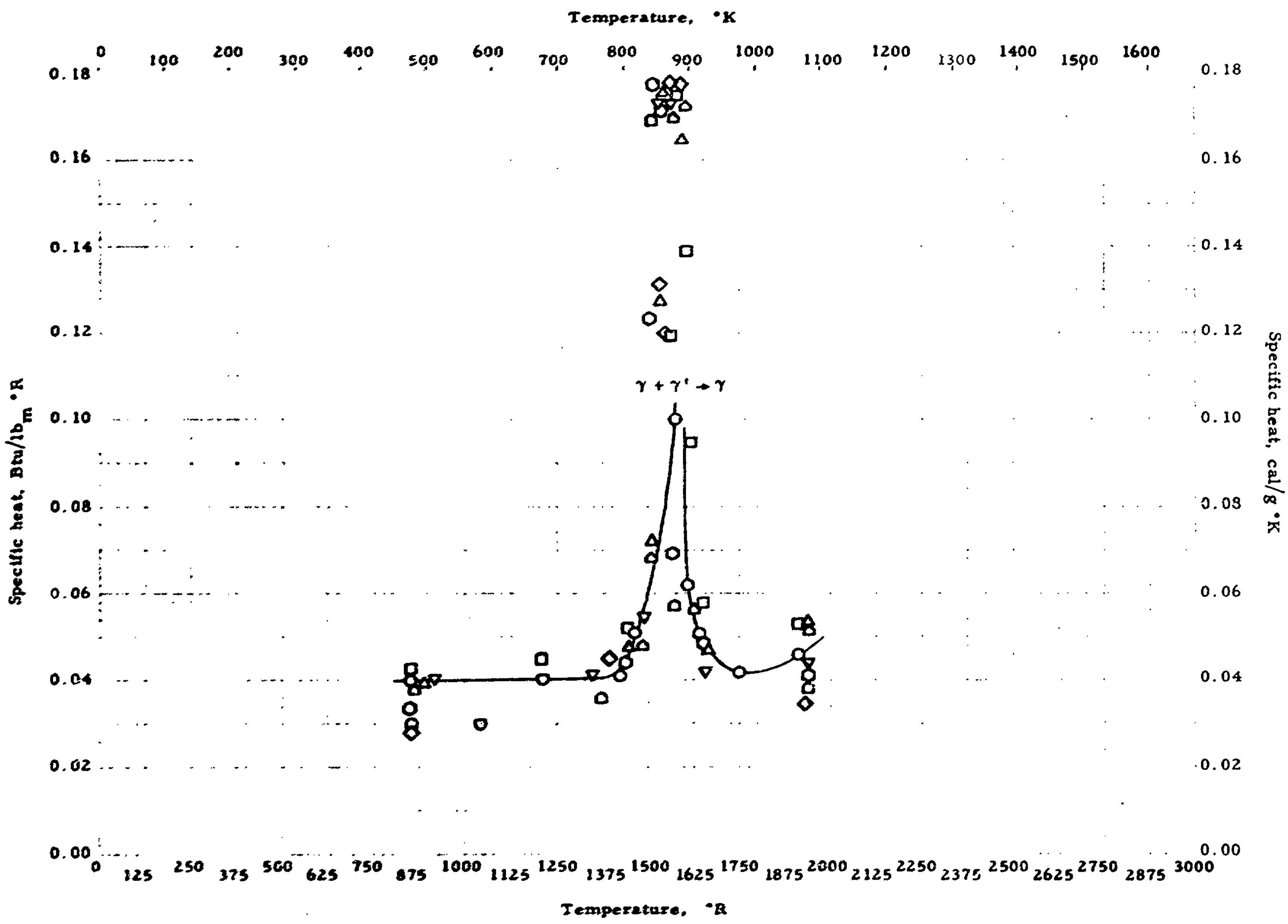
Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF URANIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bostrom, W. A., Burkart, M. W., et al.	55-111	Room 2561	12% Mo	ρ: weight in air and in CCl_4 MP: not given	Auth. est. accuracy $\pm$ 4%. Avg. of each of 4 samples quenched from 900°C
□	Del Grosso, A.	57-155	Room 2536	10% Mo	ρ: not given MP: not given	Measured at Southern Research Institute

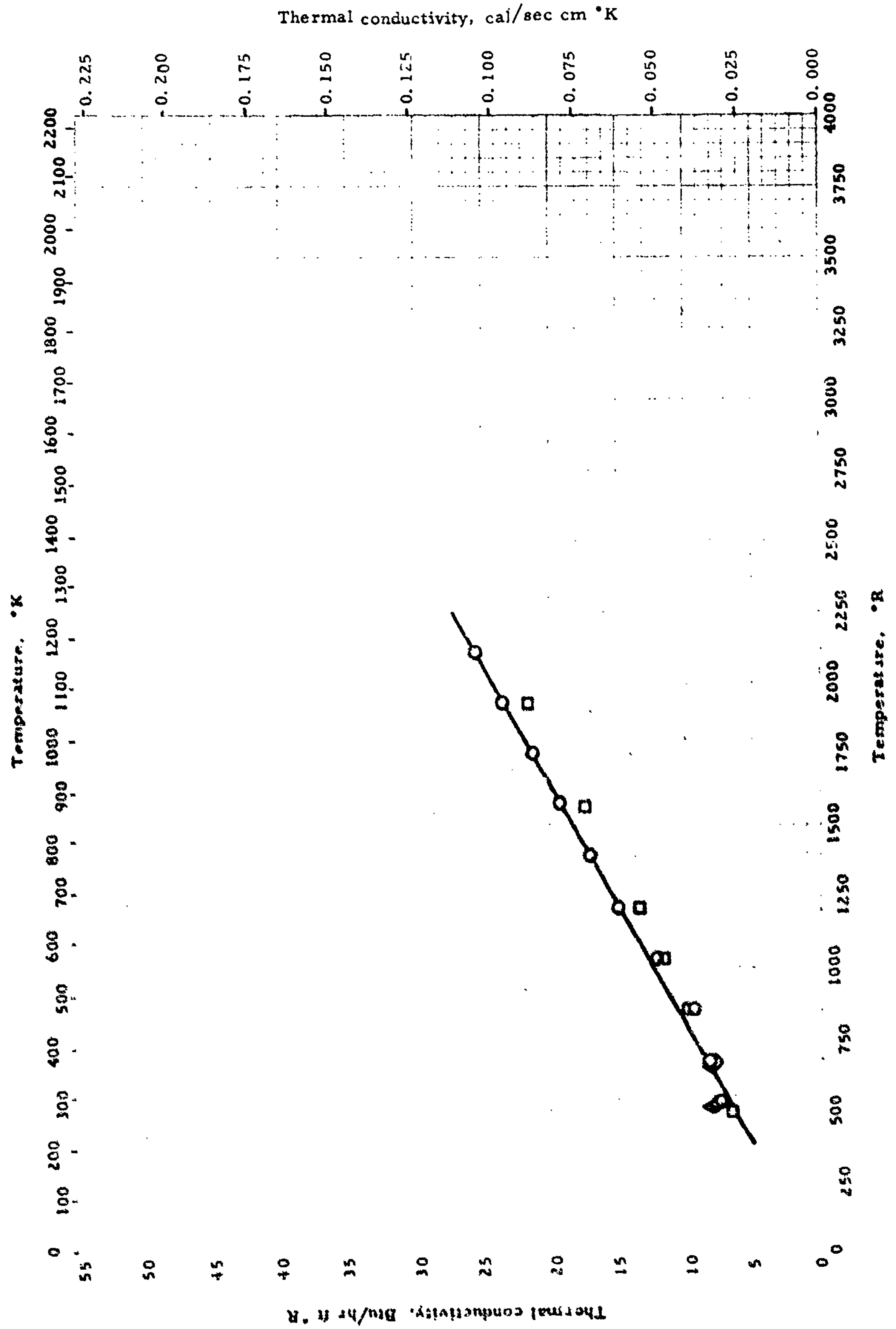


SPECIFIC HEAT -- URANIUM + MOLYBDENUM

SPECIFIC HEAT -- URANIUM + MOLYBDENUM

REFERENCE INFORMATION

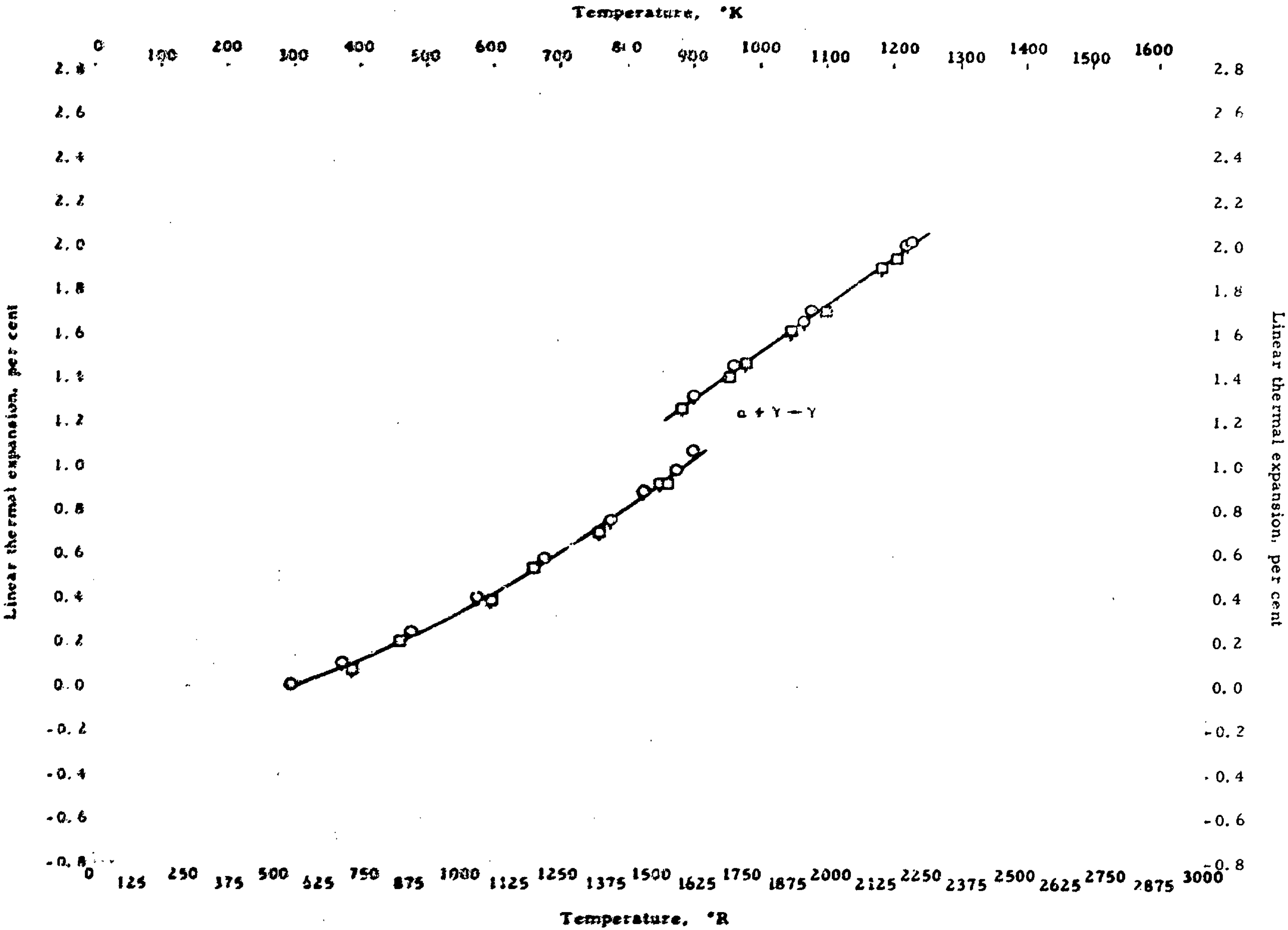
Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
○	Bostrom, W.A. and Halteman, E.K.	57-42	852-1914	15.2% Mo	Comparative: rate of temp. rise in sample compared with standard under same heating condition	Annealed 7 days at 590°C, held 44 days at 500°C
□	Boyle, R.F. and Halteman, E.K.	56-119	852-1932	21.5% Mo	Meas. temp. versus time for sample heated at constant heat flux	Heated 24 hr. at 900°C to γ phase, water quenched, ordered 96 days at 500°C
△	Ibid.	56-119	852-1932	7% Mo	Same as above	Heated 24 hr. at 900°C to γ phase, water quenched, ordered 7 days at 475°C
◇	Ibid.	56-119	852-1932	8% Mo	Same as above	Heated 24 hr. at 900°C to γ phase, water quenched, ordered 159 days at 400°C
▽	Ibid.	56-119	852-1932	10.5% Mo; 0.028% C	Same as above	Same as above
○	Ibid.	56-119	852-1932	11.3% Mo; 0.046% C; 0.0035% N_2	Same as above	Same as above
○	Ibid.	56-119	852-1932	12% Mo; 0.008% C; 0.0071% N_2	Same as above	Heated 24 hr. at 900°C to γ phase, water quenched, ordered 243 days at 400°C
◁	Ibid.	56-119	852-1932	15.2% Mo; 0.028% C; 0.007% N_2	Same as above	Heated 24 hr. at 900°C to γ phase, water quenched, ordered 95 days at 570°C
□	Bostrom, W.A., Burkart, M.W. et al.	55-111	1032-1212	12% Mo	Not given	α uranium + ε phase



THERMAL CONDUCTIVITY -- URANIUM + MOLYBDENUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Dayton, R. W. and Tipton Jr., C. R.	57-154	528-2112	Fissium Alloy. Nominal: 95% U; 2.46% Mo; 1.96% Ru, 0.28% Rb, 0.19% Pr; 0.10% Zr; 0.01% Nb	Comparative; rods	Auth. est. accuracy ± 5%. Meas. by R. F. Dickerson and N. E. Daniel
□	Del Grosso, A.	57-155	492-1932	90% U, 10% Mo	Not given	From data reported by Battelle Memorial Inst.
△	Bostrom, W. A., Burkart, M. W. et al.	55-111	510-672	92% U; 8% Mo	Not given	α U + ε
◇	Ibid.	55-111	510-672	88% U, 12% Mo	Not given	α U + ε

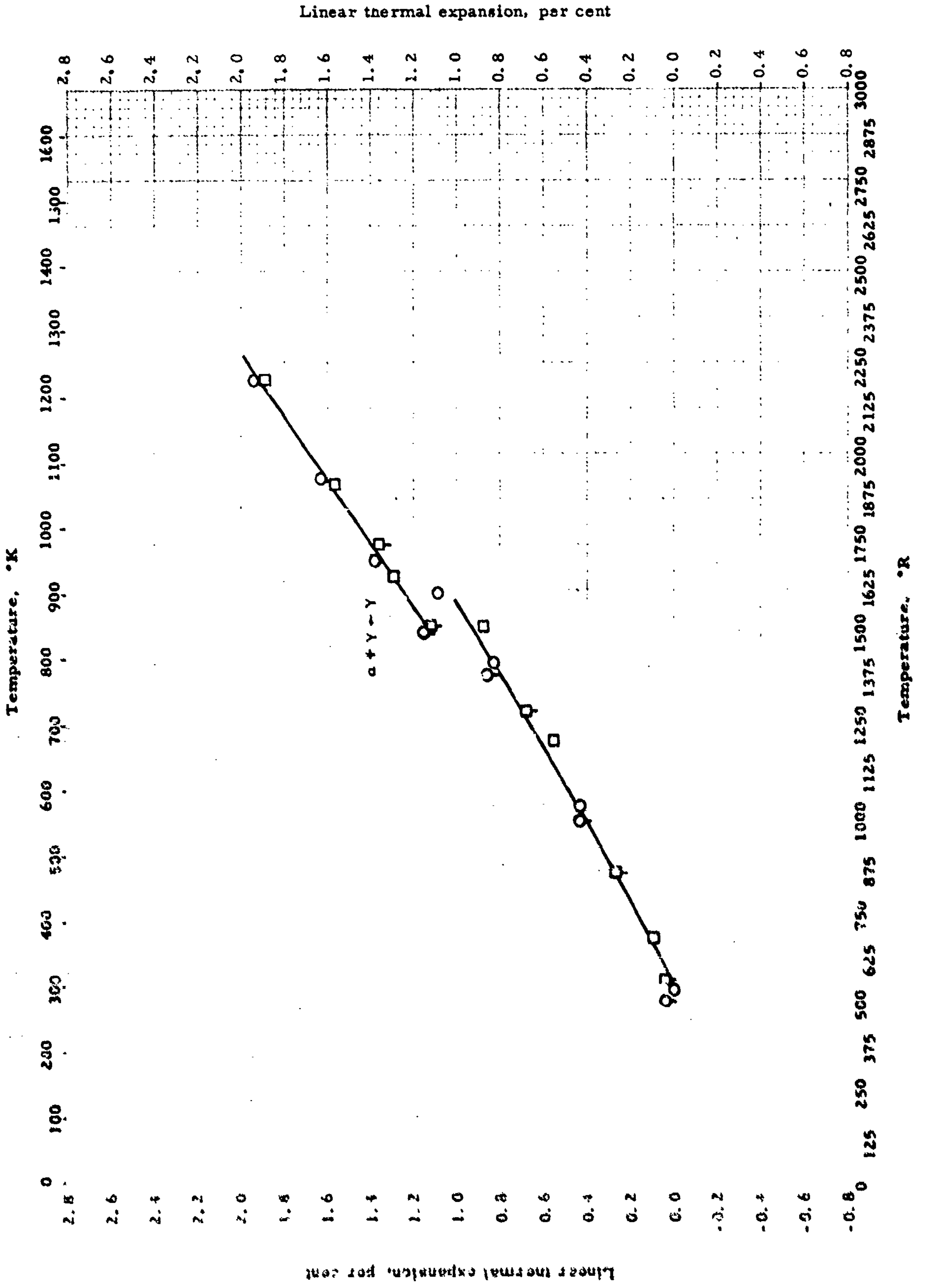


LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(3.3% Mo)

LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(3.3% Mo)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A., Dickerson, R. F. and Murr, W. E.	56-128	530-2200	3.34% Mo	Quartz tube recording dilatometer, in vacuum. Max. heating or cooling rate 5°C/min.	Heated 1 hr. at 800°C, air cooled. Specimen protected in glass envelope. ○ - heating ⍜ - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	Heated 1 hr. at 800°C, water quenched. □ - heating ⍞ - cooling

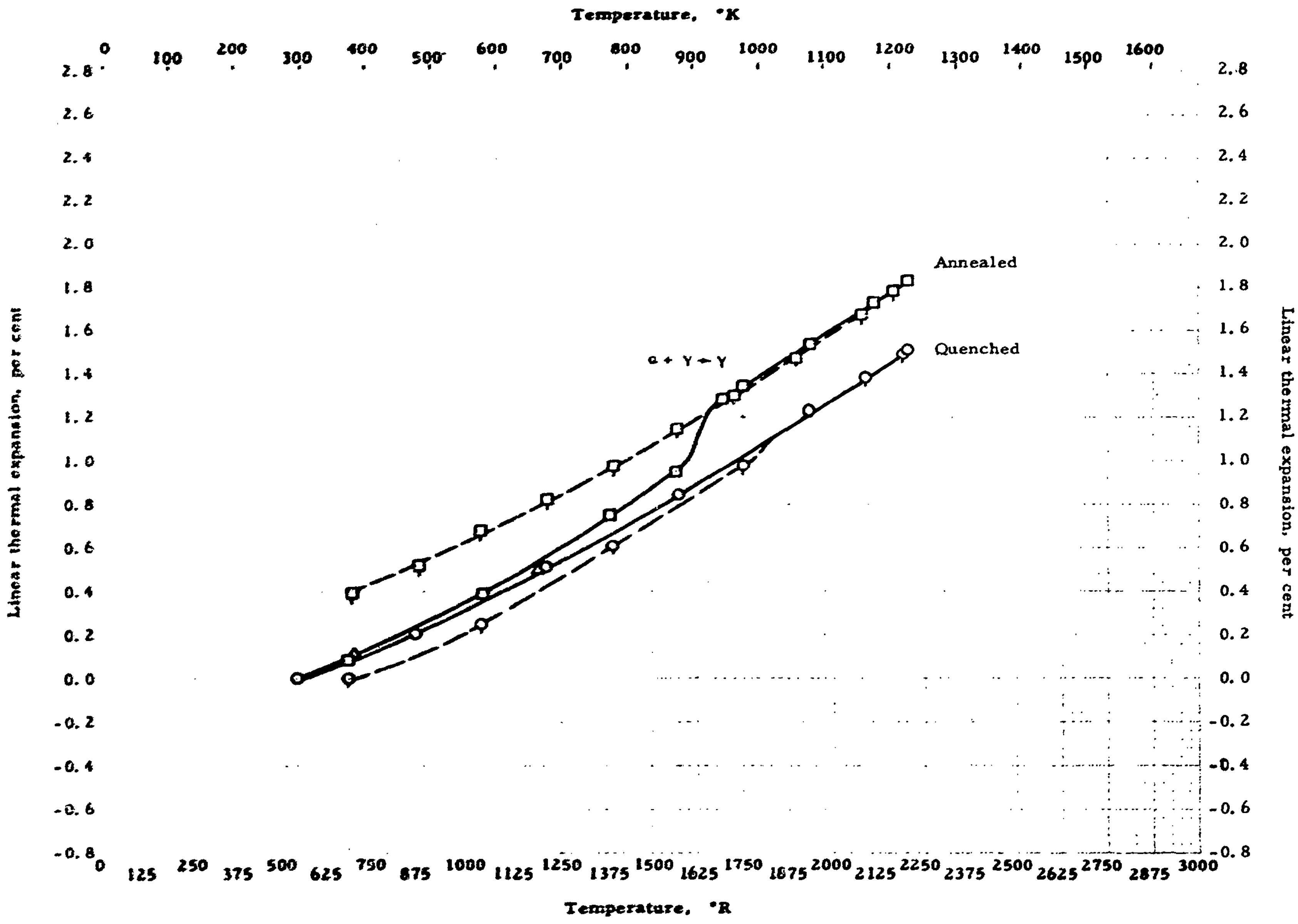


LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(5% Mo)

LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(5% Mo)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A., Dickerson, R. F. and Murr, W. E.	56-128	530-2202	4.99% Mo	Quartz tube recording dilatometer, in vacuum. Max. heating or cooling rate 5°C/min.	Held 1 hr. at 800°C, water quenched ○ - heating ○ - cooling
□	Ibid.	56-128	530-2202	Same as above	Same as above	Held 1 hr. at 800°C, furnace cooled to 500°C, held 24 hr., furnace cooled □ - heating □ - cooling

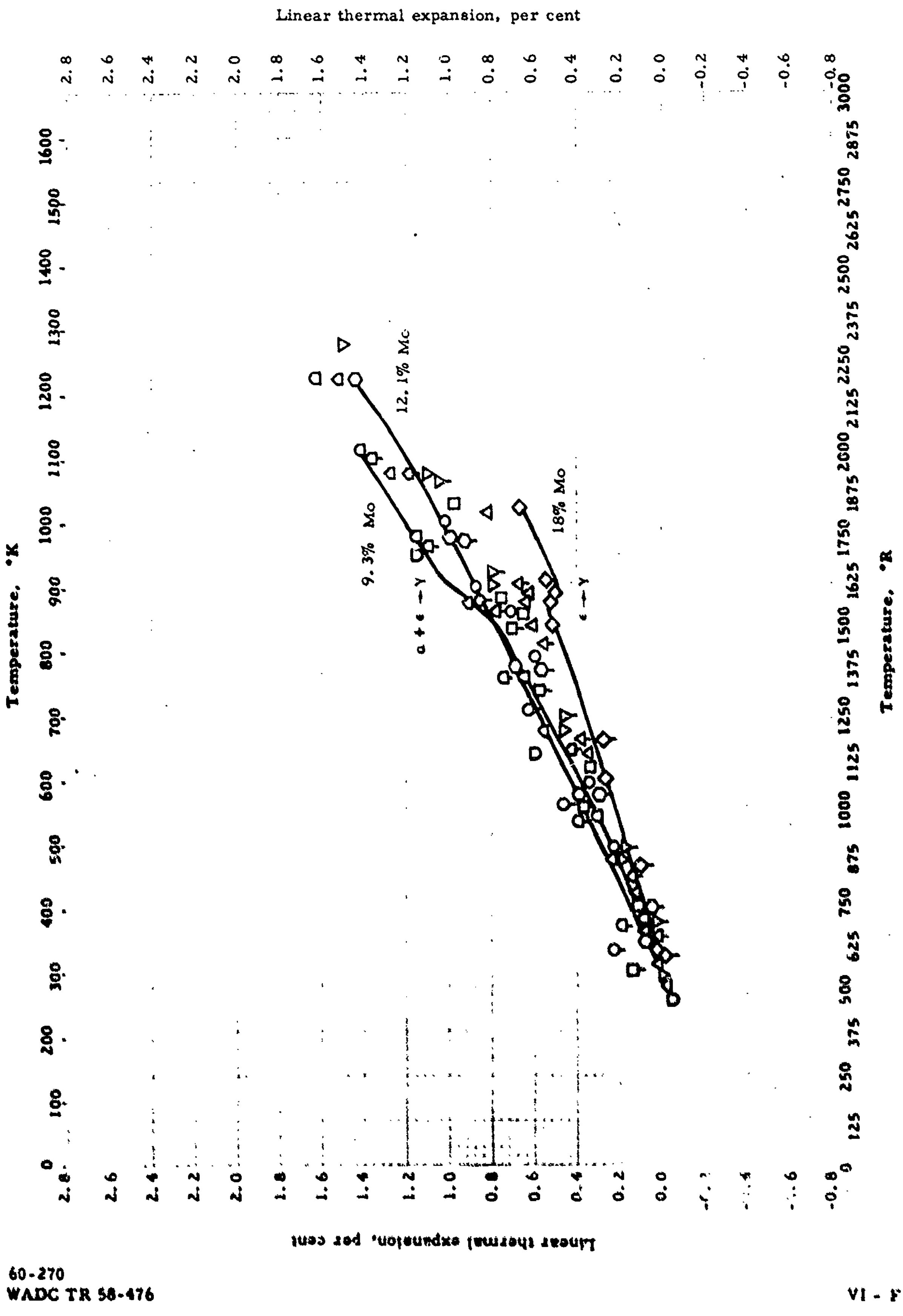


LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(7 - 8% Mo)

LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(7 - 8% Mo)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A., Dickerson, R. F. and Murr, W. E.	56-128	530-2202	7.18% Mo	Quartz tube recording dilatometer, in vacuum. Max. heating and cooling rate of 5°C/min	Held 1 hr. at 800°C, water quenched ○ - heating ⚲ - cooling
□	Ibid.	56-128	530-2202	Same as above	Same as above	Held 1 hr. at 800°C, furnace cooled to 500°C, held 100 hr. at 500°C, furnace cooled □ - heating □ - cooling
△	Bostrom, W. A., Burkart, M. W. et al.	55-111	670-1212	8% Mo	Not given	

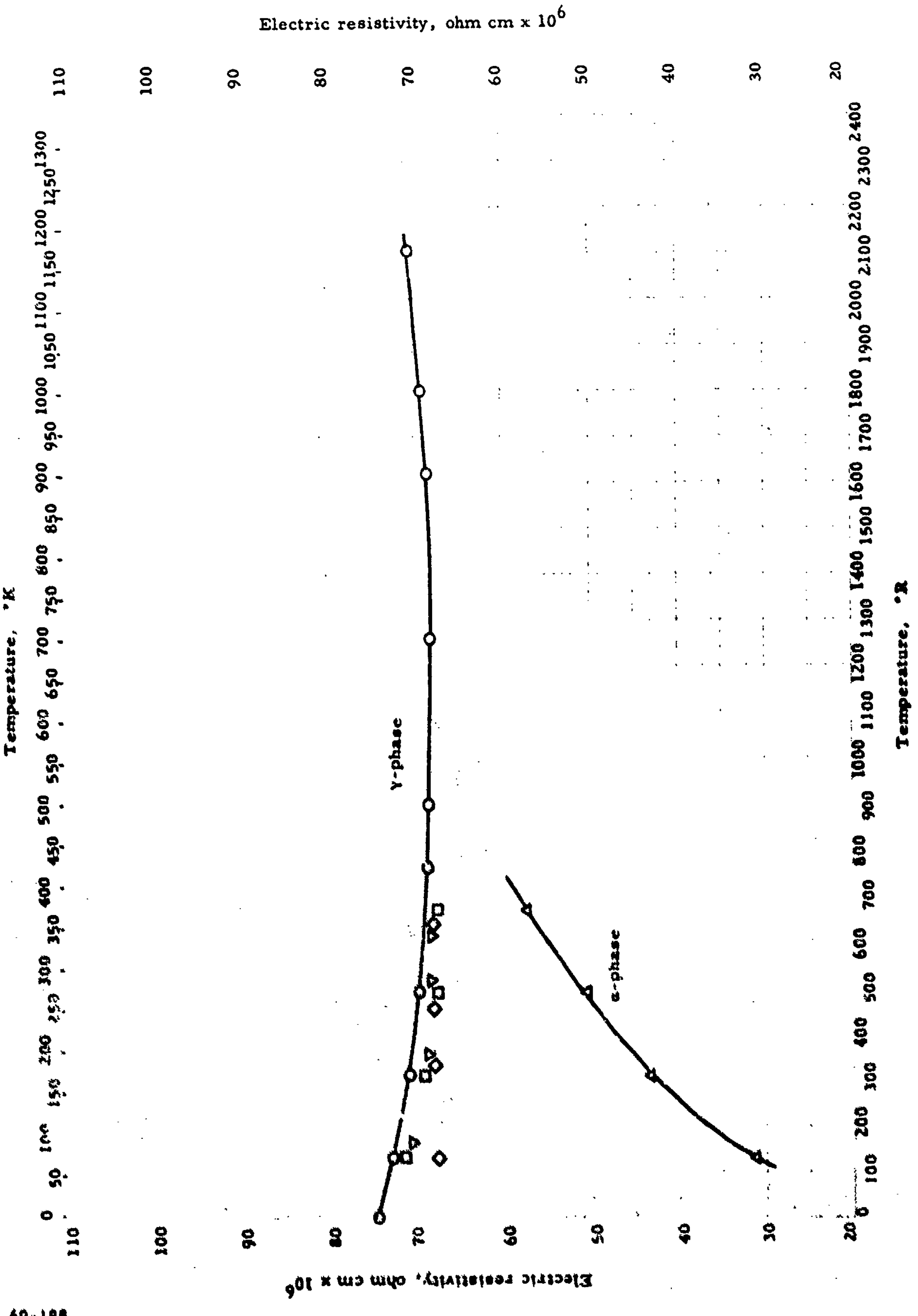


LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(9 - 18% Mo)

LINEAR THERMAL EXPANSION -- URANIUM + MOLYBDENUM
(9 - 18% Mo)

REFERENCE INFORMATION

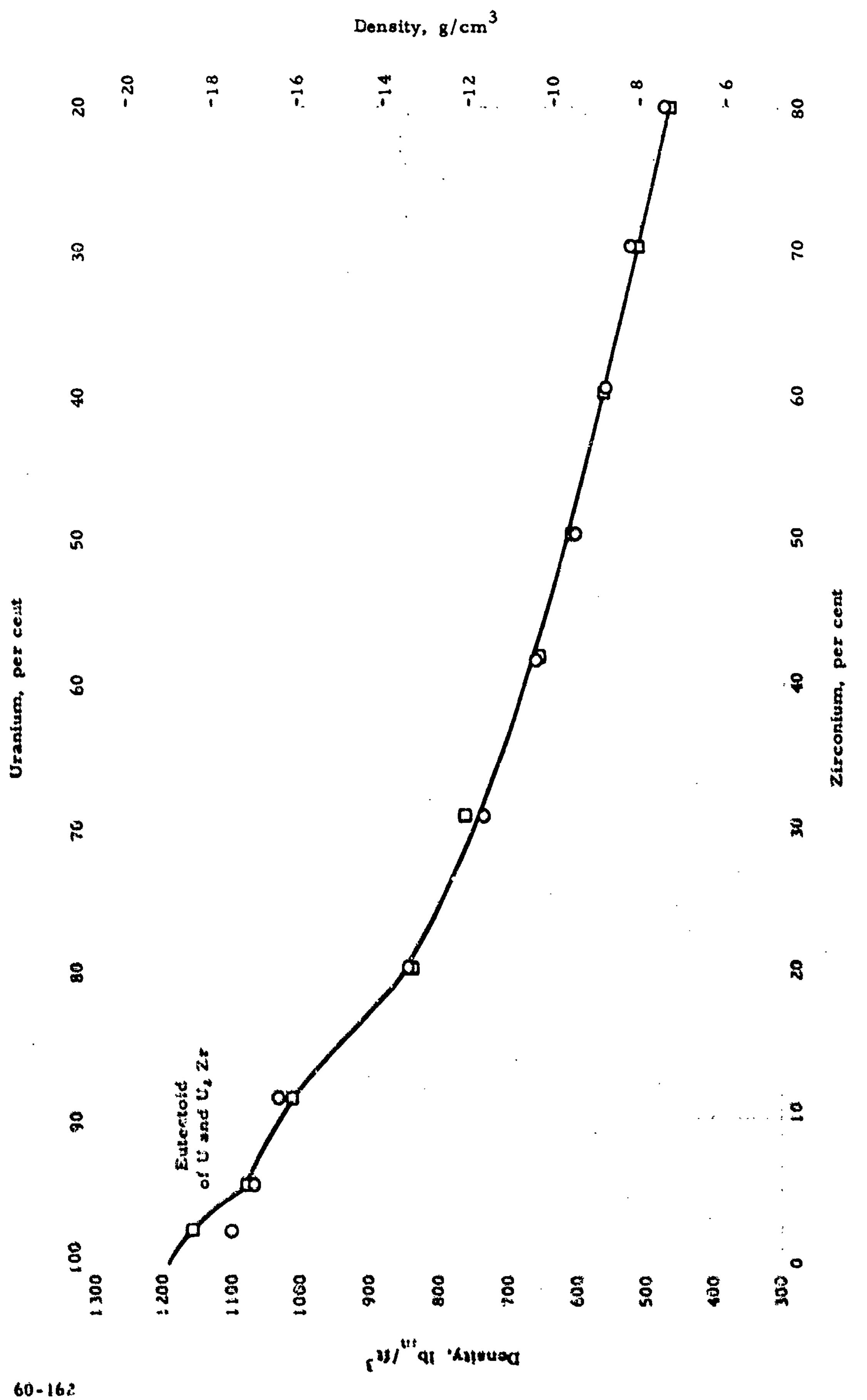
Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bostrom, W.A., Burkart, M.W. et al.	57-42 also 56-132 55-111	600-1797	9% Mo	Not described here	Annealed 1[illegible]ays at 550°C. Symbol without tail [illegible] heating, with tail is cooling
□	Ibid.	57-42 also 56-132 55-111	528-1851	12% Mo	Same as above	Same as above
△	Ibid.	57-42 also 56-132 55-111	564-1824	15% Mo	Same as above	Same as above
◇	Ibid.	57-42 also 56-132 55-111	564-1824	18% Mo	Same as above	Same as above
▽	Saller, H.A., Dickerson, R.F. and Murr, W.E.	56-128	528-2292	12.1% Mo	Quartz tube recording dilatometer in vacuum. Max heating or cooling rate 5°C/min	Held 1 hr. at 800°C, water quenched. Symbol without tail is heating, with tail is cooling
○	Ibid.	56-128	528-2292	Same as above	Same as above	Same as above except furnace cooled to 500°C, held 2 weeks at 500°C instead of quenched
○	Ibid.	56-128	528-2202	9.36% Mo	Same as above	Same as above
△	Ibid.	56-128	528-2202	Same as above	Same as above	Same as ▽
▽	Del Grosso, A.	57-155	528-1706	10% Mo	Not given	Extruded, heat treated at 900°C, water quenched. Measured at Southern Res. Inst.



ELECTRIC RESISTIVITY -- URANIUM + MOLYBDENUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Bostrom, W. R. and Halteman, E. K.	56-132 also 57-42	0-2110	9% Mo	Not given	γ-quenched. Gave relative data above 760°R, used $r_{540°R}$ = 69.5 x 10^{-6} ohm cm
□	Ibid.	56-132 also 57-42	132-672	Same as above	Same as above	γ-quenched, 0.07% burnup
△	Ibid.	56-132 also 57-42	132-672	Same as above	Same as above	γ-quenched, then α-transformed by 13 days at 525°C
◇	Ibid.	56-132 also 57-42	132-672	Same as above	Same as above	γ-quenched, then α-transformed by 13 days at 525°C. 0.088% burnup
▽	Ibid.	56-132 also 57-42	132-672	Same as above	Same as above	γ-quenched, then α-transformed by 13 days at 525°C. 0.092% burnup



DENSITY -- URANIUM + ZIRCONIUM

DENSITY -- URANIUM + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A. and Rough, F. A.	53-109	Room	2 - 80% Zr	Not given	Heat treated 1 hr at 800°C, water quenched
◻	Ibid	53-109	Room	2 - 80% Zr	Same as above	Heat treated 24 hrs at 575°C, furnace cooled

PROPERTIES OF URANIUM + ZIRCONIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 90% U . .	2570°R	1430°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

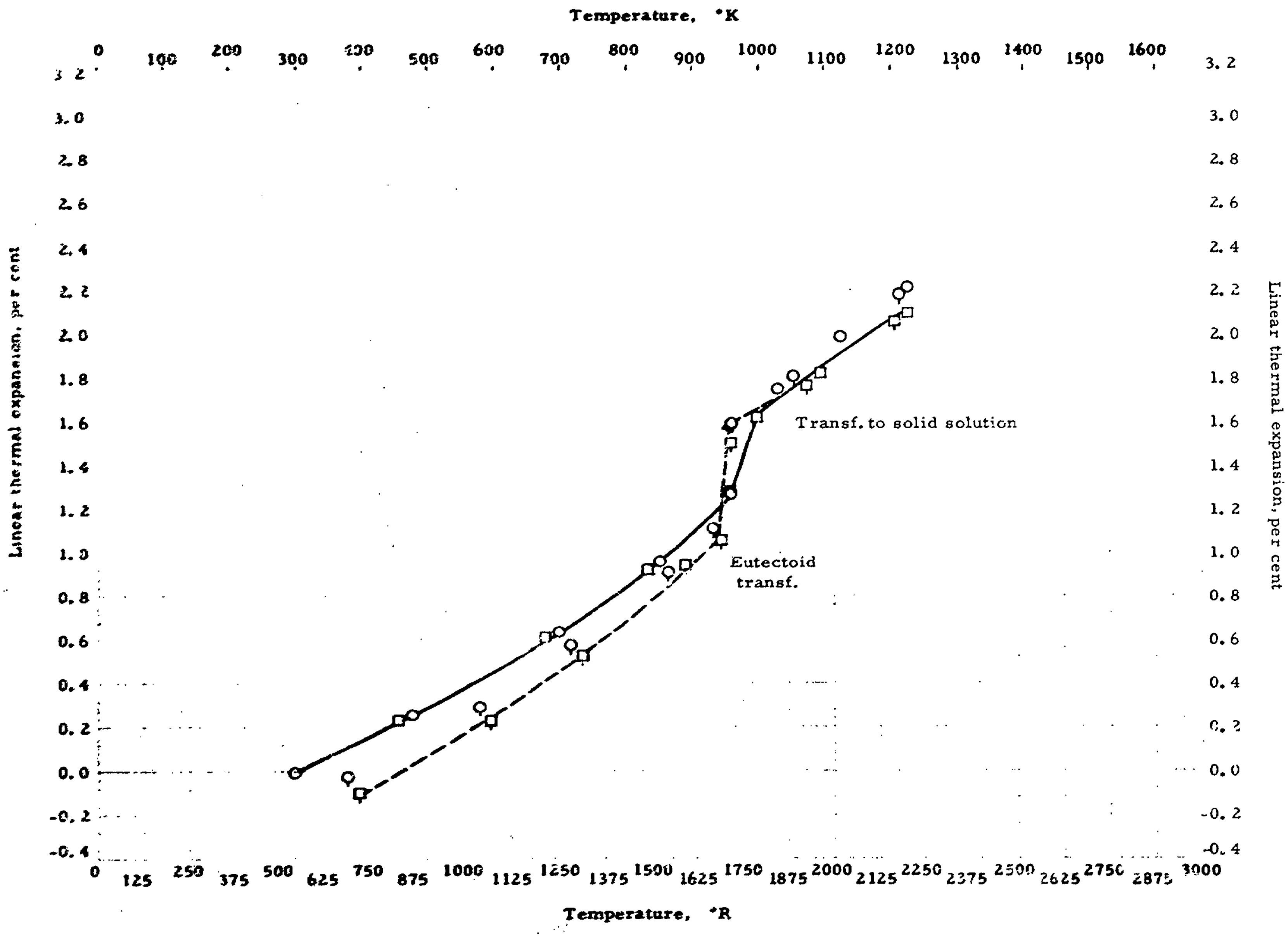
REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
Melting Point:		°R	°K
	○	2570	1428
	□	2659	1477
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF URANIUM + ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Carlson, O.N.	50-41	2570-2759	90.0% U; 4.25% Th; 3.86% Zr	MP: observation of first liquid drop, optical pyrometer sighting on black body cavity	
□	Ibid.	50-41	2570-2759	33.3% U; 33.3% Th; 33.3% Zr	MP: same as above	

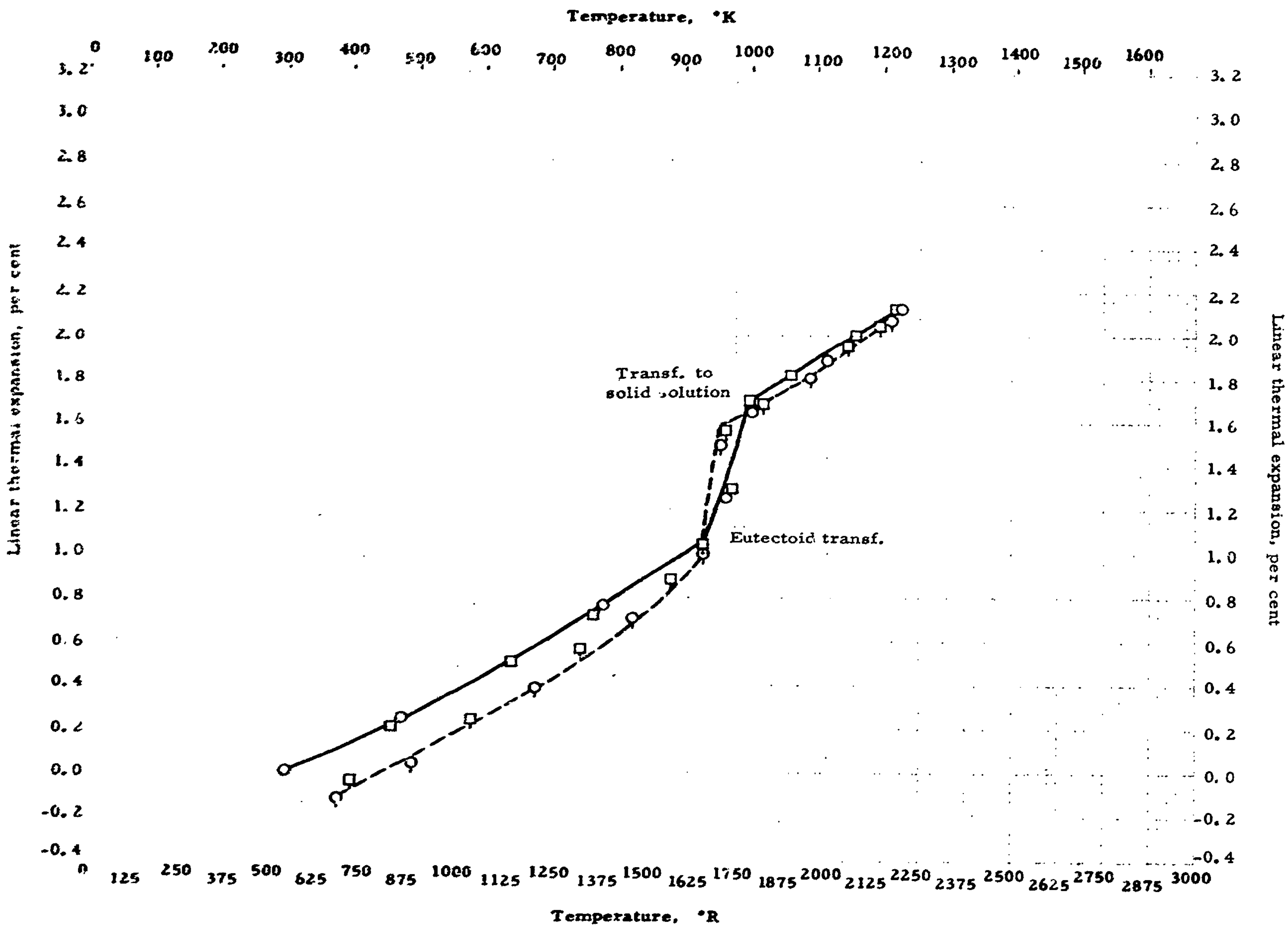


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(3% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM (3% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Saller, H. A., Dickerson, R. F. and Murr, W. E.	56-128	530-2200	2.95% Zr	Quartz tube recording dilatometer. Tested in vacuum	Heated 1 hr. at 800°C and 24 hr. at 670°C, furnace cooled O - heating Ọ - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	1 hr. at 800°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, 2 hr. 550°C □ - heating □̣ - cooling

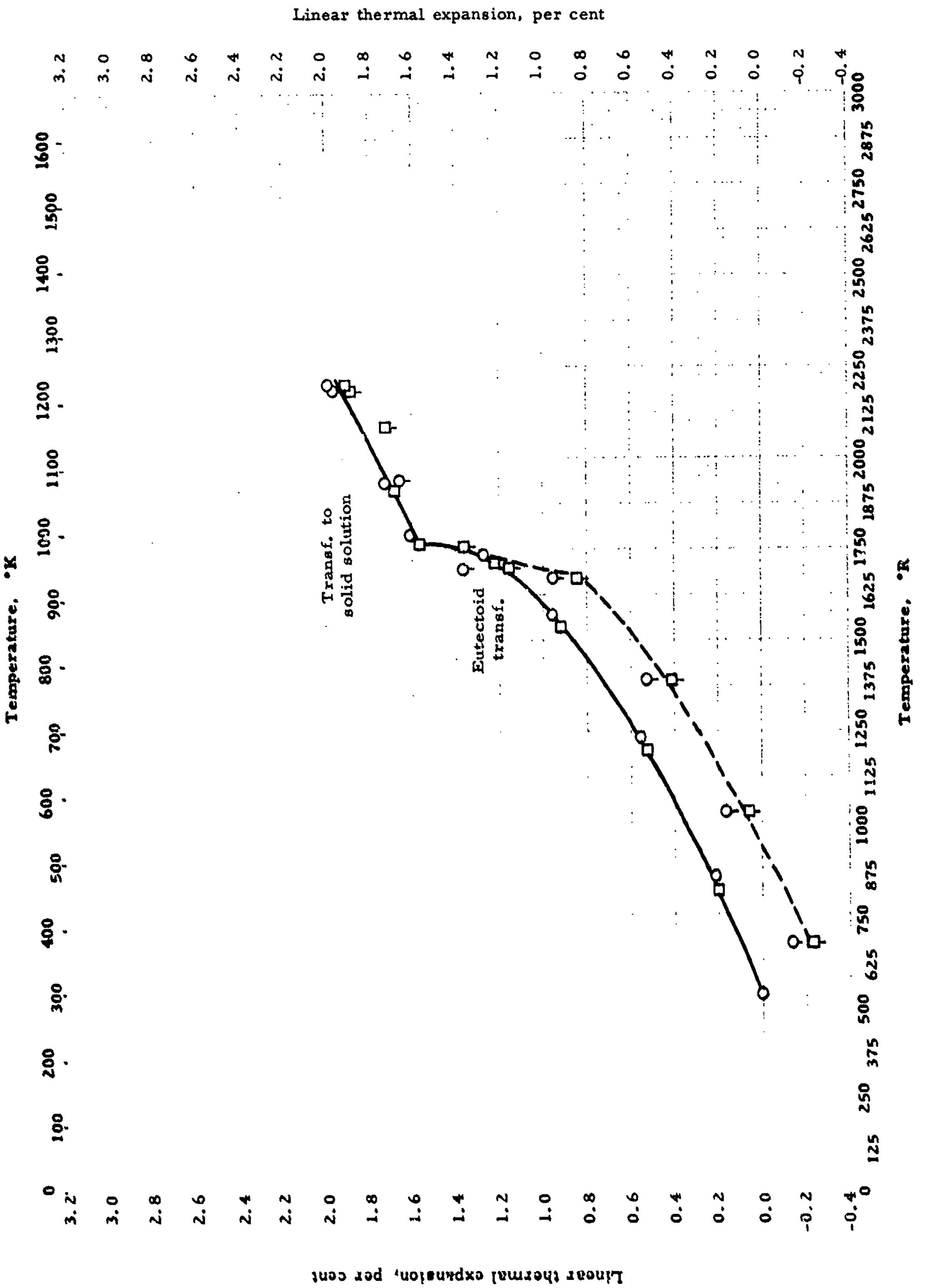


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(5% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM (5% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H.R., Dickerson, R.F. and Murr, W.E.	56-128	530-2200	4.96% Zr	Quartz tube recording dilatometer, tested in vac.	Heated 1 hr. at 800°C and 24 hr. at 670°C, furnace cooled ○ - heating ϙ - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	1 hr. at 800°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, 2 hr. at 550°C □ - heating □ - cooling

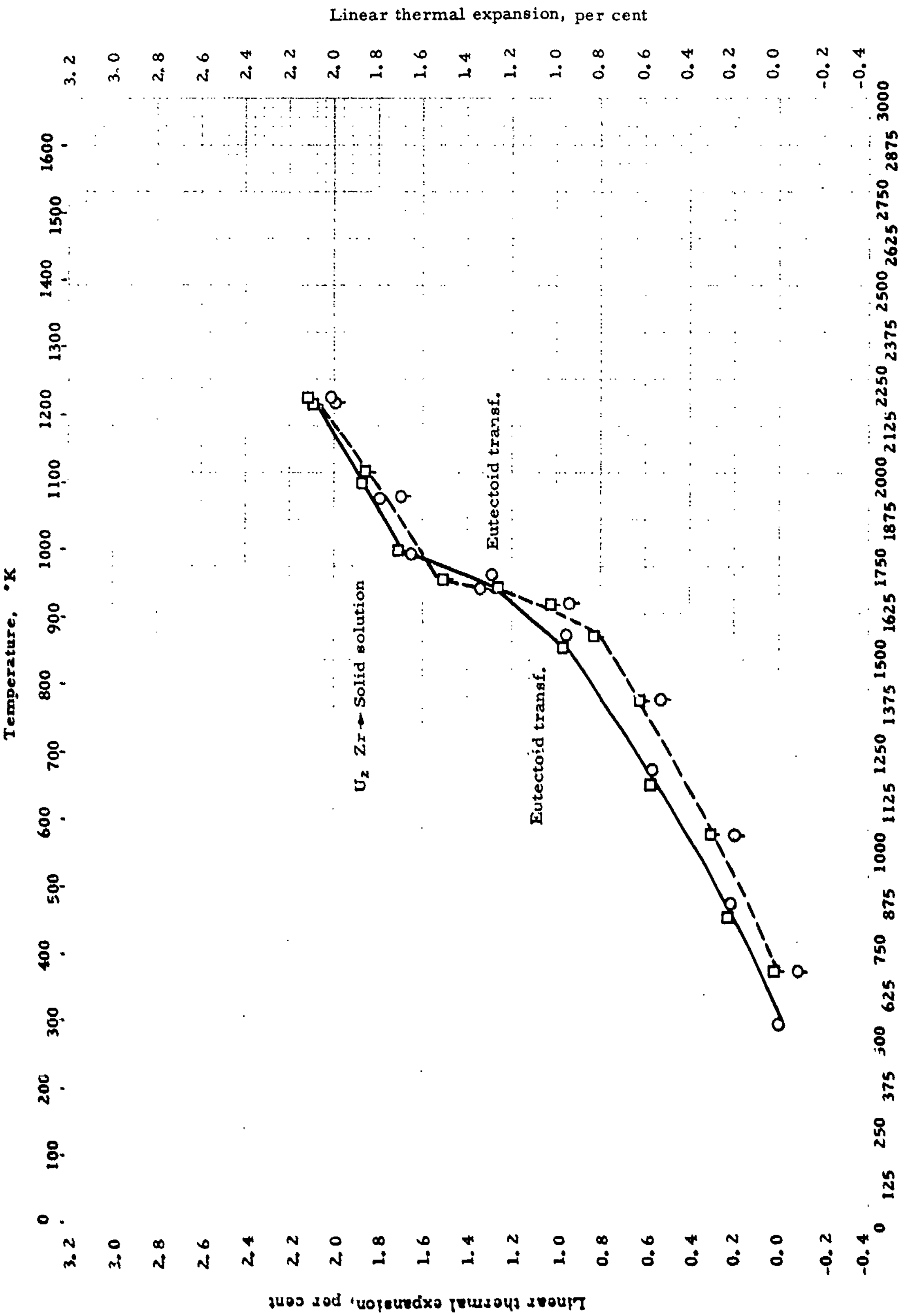


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(7% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(7% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Saller, H.A., Dickerson, R.F. and Murr, W.E.	56-128	530-2200	7.07% Zr	Quartz tube recording dilatometer, tested in vac.	Heated 1 hr. at 800°C and 24 hr. at 670°C, furnace cooled O - heating ♀ - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	1 hr. at 800°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, isothermally transformed 2 hr. at 550°C, 5 min. at 780°C, 2 hr. at 550°C □ - heating □ - cooling

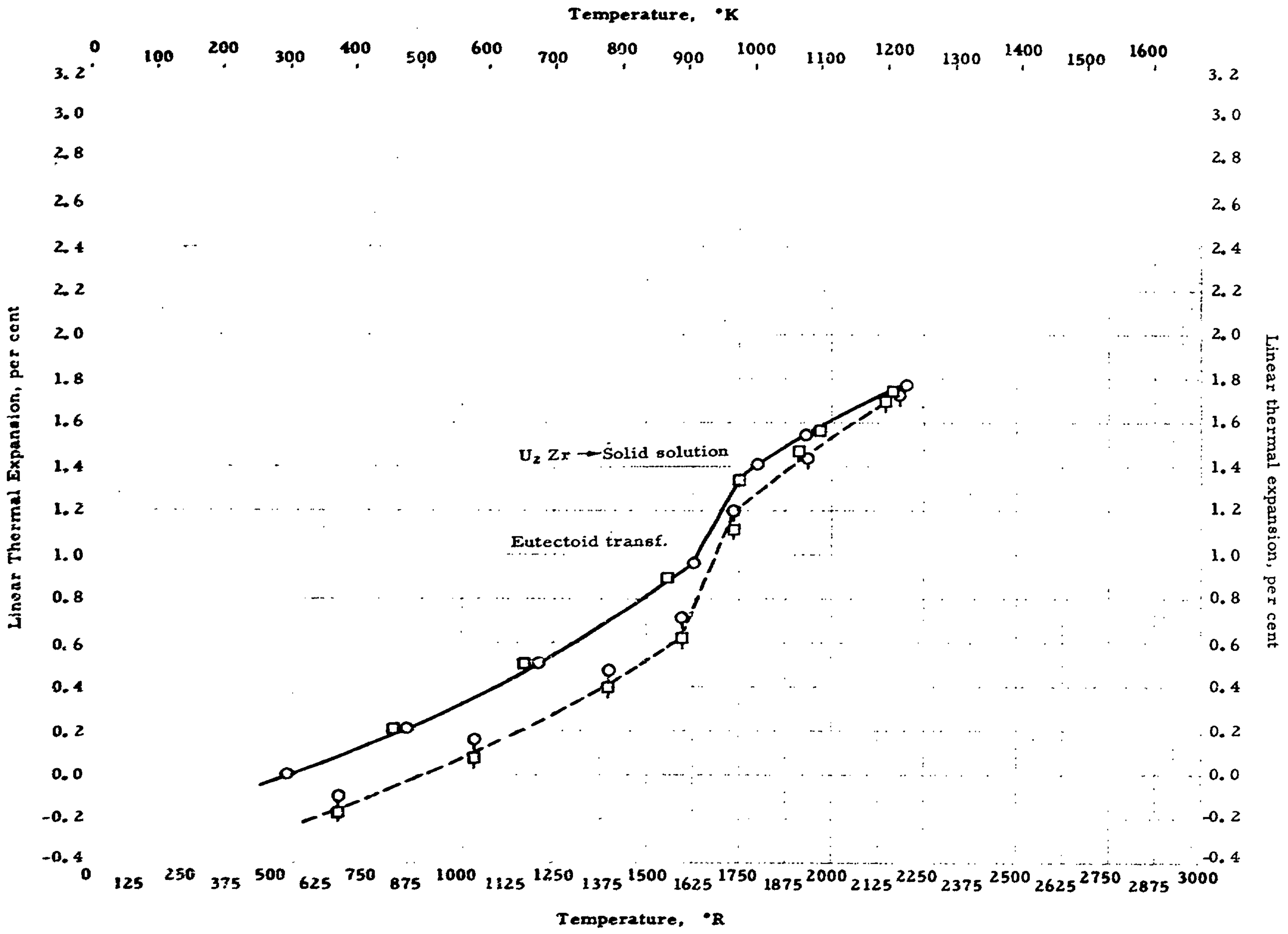


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(9.9% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(9.9% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H.A., Dickerson, R.F. and Murr, W.E.	56-128	530-2200	9.86% Zr	Quartz tube recording dilatometer, tested in vac.	1 hr. at 800°C, 24 hr. at 670°C, furnace cooled. ○ - heating ⚲ - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	1 hr. at 800°C, furnace cooled to 750°C, furnace cooled from 750°C to 570°C at 1/2°C/min. □ - heating ⚲ - cooling

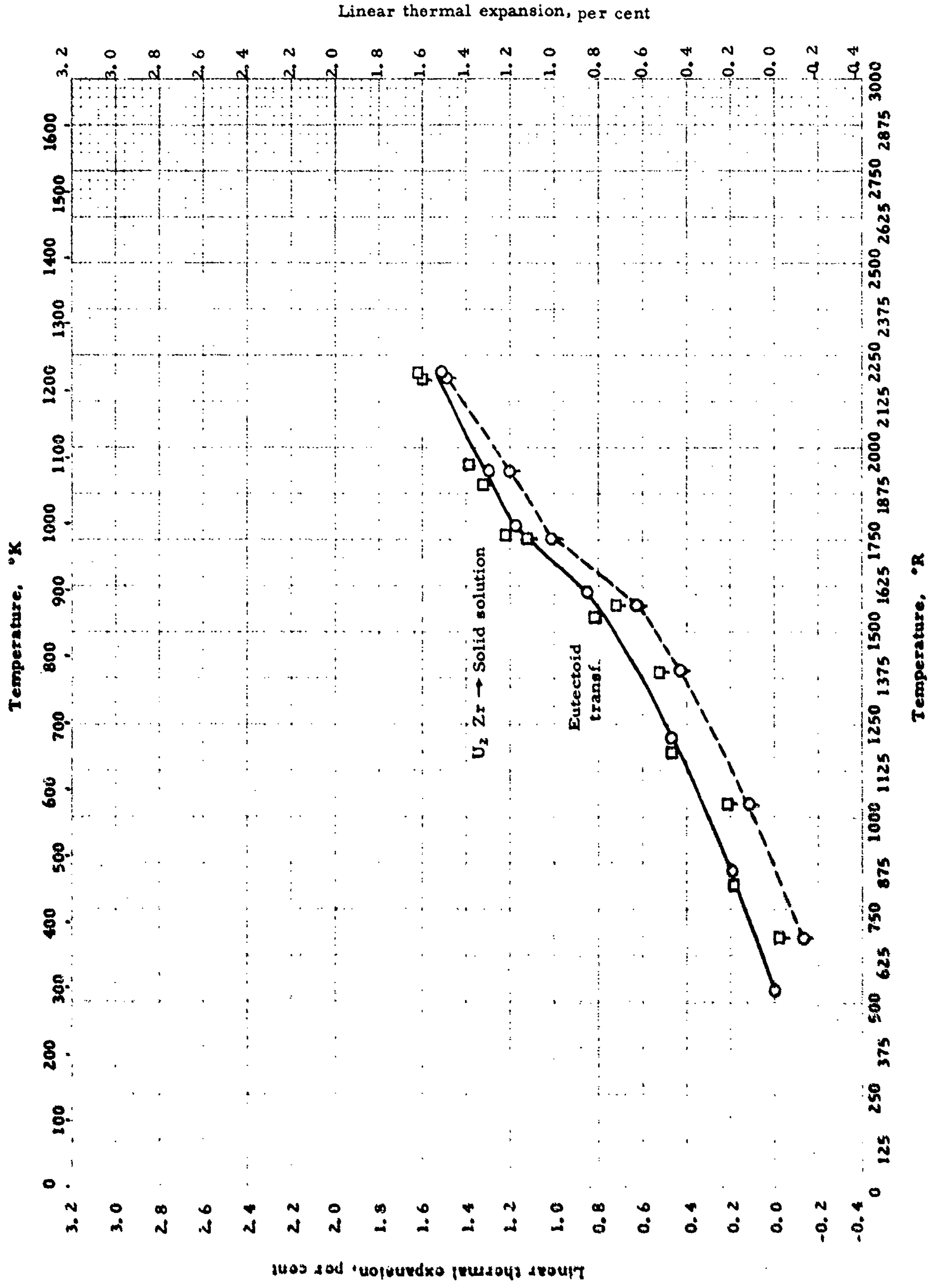


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(15.5% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(15.5% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Sailer, H. A., Dickerson, R. F. and Murr, W. E.	56-128	530-2200	15.5% Zr	Quartz tube recording dilatometer, tested in vac.	Heated 1 hr. at 800°C, 24 hr. at 670°C, furnace cooled O - heating, Q - cooling
□	Ibid.	56-128	530-2200	Same as above	Same as above	Heated 1 hr. at 800°C, furnace cooled to 750°C. Furnace cooled from 750°C to 570°C at 1/2°C/min.

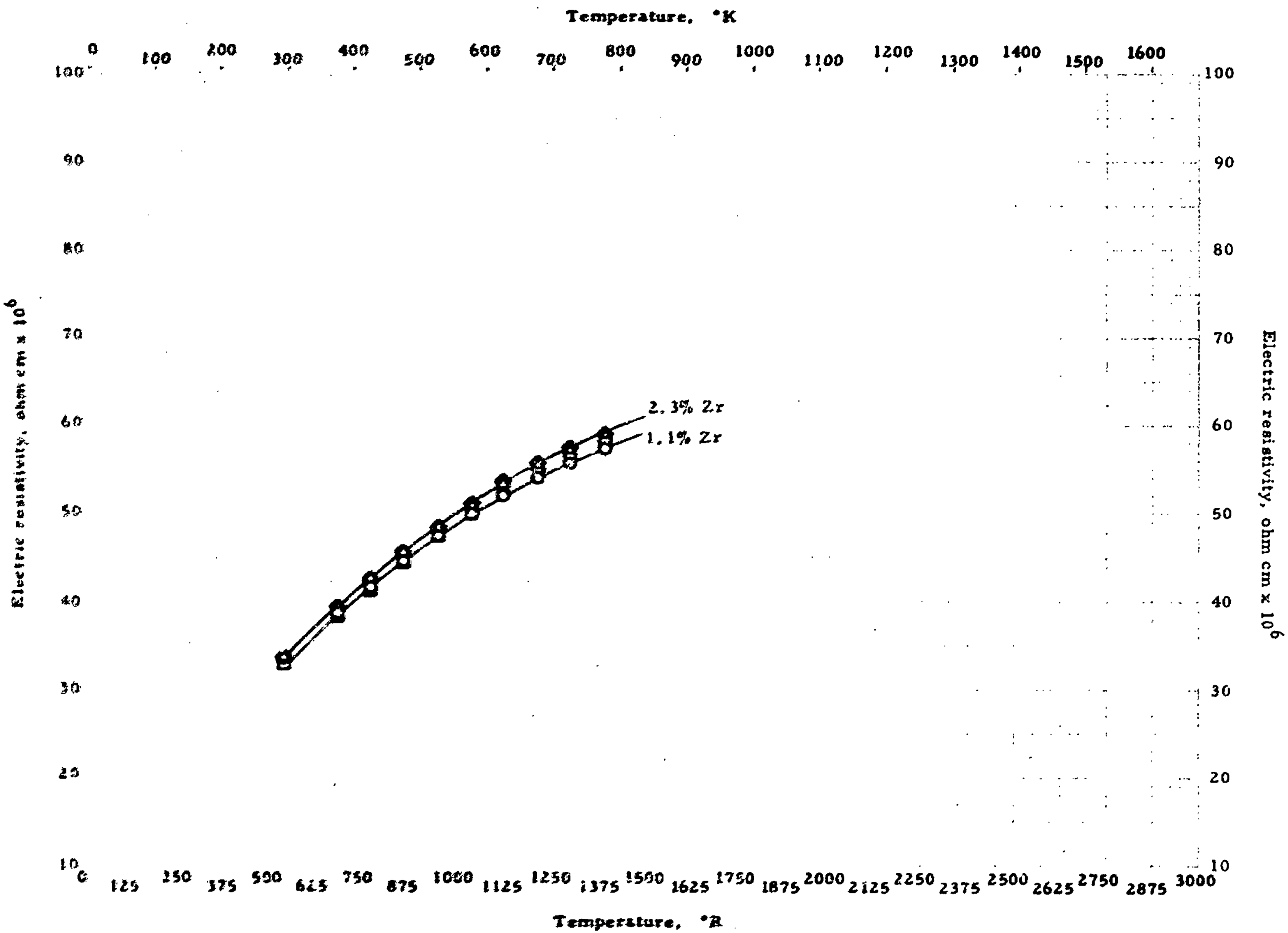


LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM
(20% Zr)

LINEAR THERMAL EXPANSION -- URANIUM + ZIRCONIUM (20% Zr)

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Saller, H. A., Dickerson, R. F. and Murr, W. E.	56-128	528-2200	20% Zr	Quartz tube recording dilatometer, tested in vacuum	1 hr. 800 °C, furnace cooled to 750 °C, furnace cooled from 750 °C to 570 °C at 1/2 °C/min. O - heating ♀ - cooling
□	Ibid.	56-128	528-2200	Same as above	Same as above	1 hr. 800 °C, isothermally transformed at 500 °C for 2 hr., water quenched □ - heating □ - cooling



ELECTRIC RESISTIVITY -- URANIUM + ZIRCONIUM + X

ELECTRIC RESISTIVITY -- URANIUM + ZIRCONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Saller, H. A. and Rough, F. A.	55-23	528-1932	1.13% Zr; < 0.01% C	Potential drop	Heated 1 hr. at 725°C in vacuum, water quenched
□	Ibid.	55-23	528-1932	1.22% Zr; 0.31% C	Same as above	Same as above
△	Ibid.	55-23	528-1932	2.22% Zr; < 0.01% C	Same as above	Heated 1 hr. at 800°C in vacuum, ½ hr. at 500°C, air cooled
◇	Ibid.	55-23	528-1932	2.25% Zr; 0.40% C	Same as above	Same as above

PROPERTIES OF URANIUM + BISMUTH

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 47% Bi	850 lb_m/ft^3	13.6 g/cm^3
Melting Point 47% Bi . .	3060 °R	1650 °K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	O	849	13.6

		°R	°K
Melting Point:	O	3057 ± 45	1648 ± 25

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF URANIUM + BISMUTH

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Teitel, R.J.	57-161	Room 3012-3102	UBi: 53.2% U; 46.8% Bi	ρ: computed from x-ray measurements of lattice MP: break in time-temp curve	Made from 99.99% pure Bi and U

PROPERTIES OF URANIUM + COBALT

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 20% Co . . .	1105 lb_m/ft^3	17.7 g/cm^3
Melting Point 20% Co . .	1950°R*	1080°K*
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	1105	17.7
	□	959.5	15.37

	°R	°K
Melting Point:		

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

PROPERTIES OF URANIUM + COBALT

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Baenziger, N. C. et al.	50-55 also 48-25	Room	$U_6 Co_{1.09}$: 95.7% U; 4.3% Co	ρ: computed from x-ray measurements of lattice	Single crystals
□	Ibid.	50-55 also 48-25	Room	UCo: 80.2% U; 19.8% Co	ρ: same as above	Same as above

PROPERTIES OF URANIUM + IRON

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 10.7% Fe	986 lb_m/ft^3	15.8 g/cm^3
Melting Point 11% Fe . .	1800 °R *	1000 °K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3
○	986	15.8
□	1105	17.7
△	825	13.21

Melting Point:

	°R	°K
◇	1959	1088
▽	2715	1508

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF URANIUM + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Massachusetts Inst. of Technology	53-126	Room	10.7% Fe; 0.0335% C	ρ: weight and volume by water displacement	Cast at 5 - 35μ Hg vacuum. Meas. by W. C. Paynton and H. F. Sawyer
□	Baenziger, N. C., et al.	50-55 also 48-25	Room	U_6Fe	ρ: computed from x-ray measurements of lattice	
△	Ibid.	50-55 48-25	Room	UFe_2	ρ: Same as above	
◇	Gordon, P. and Kaufmann, A. R.	50-52	1959	U_6Fe	MP: break in time-temp. curve	
▽	Ibid.	50-52	2715	UFe_2	MP: Same as above	

PROPERTIES OF URANIUM + LEAD

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 47% Pb . .	855 lb_m/ft^3	13.7 g/cm^3
Melting Point 47% Pb .	2800°R	1280°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	O	855	13.7

		°R	°K
Melting Point:	O	2796	1280

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF URANIUM + LEAD

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Teitel, R.J.	56-130	Room 2796	U Pb: 53.5% U; 46.5% Pb	ρ: computed from x-ray measurements of lattice MP: break in time-temp. curve	Layers of U and Pb outgassed at 100°C, heated in H_2 atm. at 250°C to convert U into UH_3 powder, then evacuated to decompose UH_3 into U powder, and mixture heated 16 hr. at 1220°C

PROPERTIES OF URANIUM + MANGANESE

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density UMn_2	785 lb_m/ft^3	12.6 g/cm^3
Melting Point UMn_2 . . .	2500 °R	1390 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	○	1110	17.8
	□	784.7	12.57
	△	784.7	12.57
	◇	1110	17.8
	▽	1110	17.8
	⬡	780	12.5
	⌂	790.3	12.66

		°R	°K
Melting Point:	○	1798	999
	□	2507	1393

	Btu/lb_m	cal/g
Heat of Fusion:		

	Btu/lb_m	cal/g
Heat of Vaporization:		

	Btu/lb_m	cal/g
Heat of Sublimation:		

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Wilhelm, H. A. and Carlson, O. N.	49-49	Room 1798	U_6Mn: 96.3% U; 3.7% Mn.	ρ : computed from X-ray measurements of lattice MP: not given	Prepared from 99.9 + % U + 99.95 % Mn, inductively melted in BeO cruc. in A atm.
□	Ibid.	49-49	Room 2507	UMn_2:68.4% U; 31.6% Mn	ρ: same as above MP: same as above	Same as above
△	Baenziger, N. C. et al.	50-55	Room	UMn_2: 68.4% U; 31.6% Mn	ρ : computed from X-ray measurements of lattice	Single crystal
◇	Ibid.	50-55	Room	$UMn_{1.09}$: 96.0% U; 4.0% Mn	ρ : same as above	Same as above
▽	Baenziger, N. C.	48-25	Room	U_6Mn: 96.3% U; 3.7% Mn	ρ: computed from X-ray measurements of lattice	
○	Bowles, P. J. et al.	50-56	Room	UMn_2: 68.4% U; 31.6% Mn	ρ : not given	Melted from 99.5% U and 99.98% electrolytic Mn. Principal impurities: Fe, Si, C, Cu, Al and Cr.
◻	Ibid.	50-56	Room	Same as above	ρ : computed from X-ray measurements of lattice	Same as above

PROPERTIES OF URANIUM + NICKEL

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density, U_6 Ni	1100 lb_m/ft^3	17.6 g/cm^3
Melting Point, U_6 Ni. . .	1910°R*	1060°K*
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

		lb_m/ft^3	g/cm^3
<u>Density:</u>	O	1099	17.6

<u>Melting Point:</u> °R °K

<u>Heat of Fusion:</u> Btu/lb_m cal/g

<u>Heat of Vaporization:</u> Btu/lb_m cal/g

<u>Heat of Sublimation:</u> Btu/lb_m cal/g

PROPERTIES OF URANIUM + NICKEL

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Baenziger, N. C.	48-25 also 50-55	Room	U_6 Ni: 96.1% U; 3.9% Ni	ρ: computed from X-ray measurements of lattice	

PROPERTIES OF URANIUM + NIOBIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 10% Nb . .	2830°R	1570°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	2831	1573
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF URANIUM + NICBIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °F	Material Composition	Test Method	Remarks
O	Bostrom, W.A., Burkart, M.W. et al.	55-111	2831	10% Nb	MP: not given	

PROPERTIES OF URANIUM + PLUTONIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 80% U . .	2170°R	1210°K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	2166	1203
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF URANIUM + PLUTONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Argonne National Laboratories	57-114	2166	79.5% U; 20% Pu; 0.25% Mo; 0.20% Ru; 0.03% Rh; 0.02% others	MP: not given	Contained 10% fissium

PROPERTIES OF URANIUM + THORIUM + ZIRCONIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point	2659°R *	1477°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*Value for 33.3% U, 33.3% Th, 33.3% Zr.

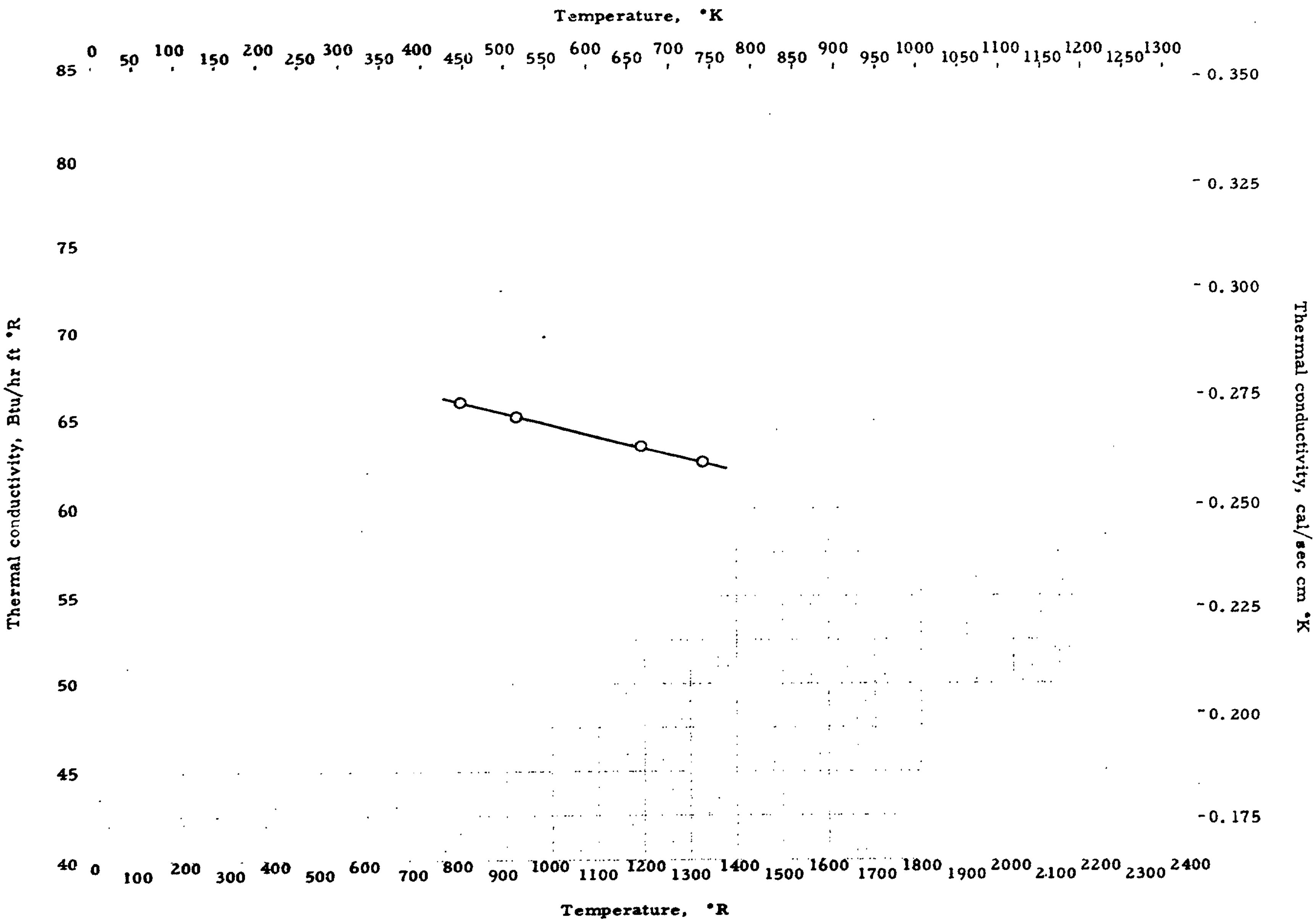
REPORTED VALUES

<u>Density:</u>		lb_m/ft^3	g/cm^3
<u>Melting Point:</u>		°R	°K
	○	2570	1428
	□	2659	1477
<u>Heat of Fusion:</u>		Btu/lb_m	cal/g
Heat of <u>Vaporization:</u>		Btu/lb_m	cal/g
Heat of <u>Sublimation:</u>		Btu/lb_m	cal/g

PROPERTIES OF URANIUM + THORIUM + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Carlson, O. N.	50-41	2570	90.0% U; 4.25% Th; 3.86% Zr	MP: observation of first liquid drop, optical pyrometer sighting on black body cavity	
□	Ibid.	50-41	2659	33.3% U; 33.3% Th; 33.3% Zr	MP: same as above	

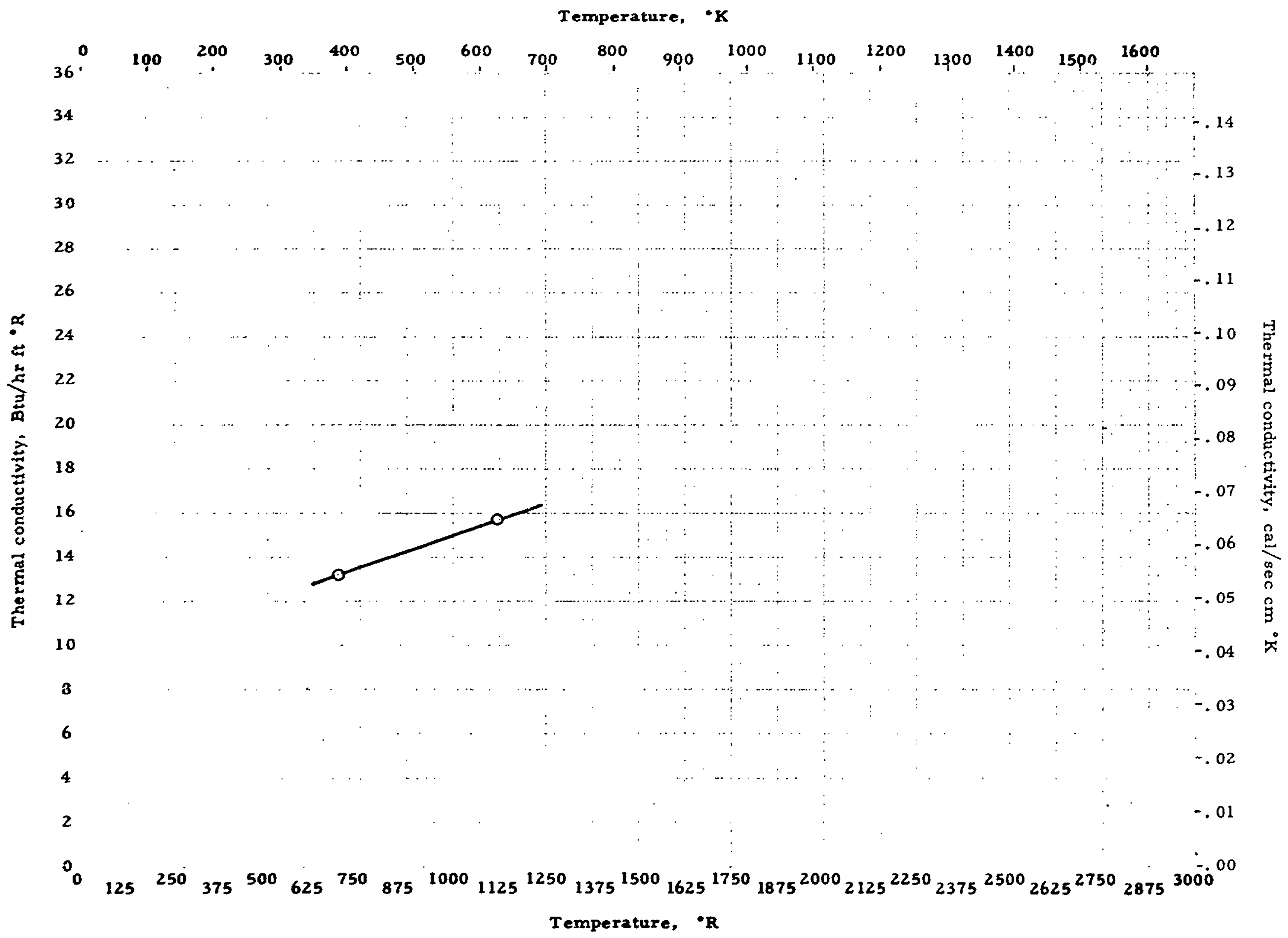


THERMAL CONDUCTIVITY -- URANIUM + MAGNESIUM

THERMAL CONDUCTIVITY -- URANIUM + MAGNESIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	McCreight, L. R.	57-148	802-1329	73.5% U; 26.5% Mg	2 methods: a) comparative, rods b) axial heat flow in rod, calorimeter sink, guarded sample	Extruded

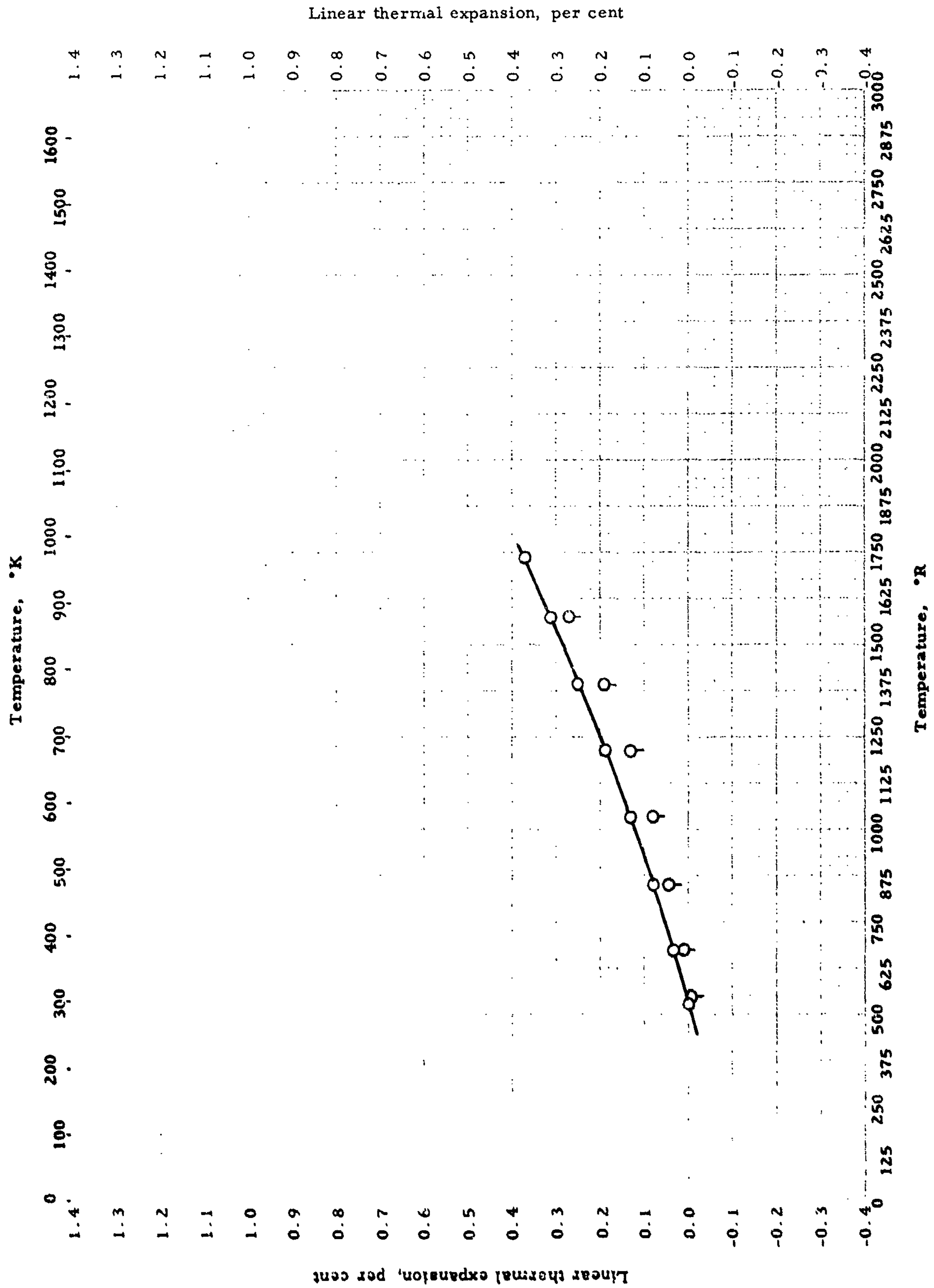


THERMAL CONDUCTIVITY -- URANIUM + NIOBIUM

THERMAL CONDUCTIVITY -- URANIUM + NIOBIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Batelle Memorial Institute	45-13	694-1122	4% Nb	Not given	

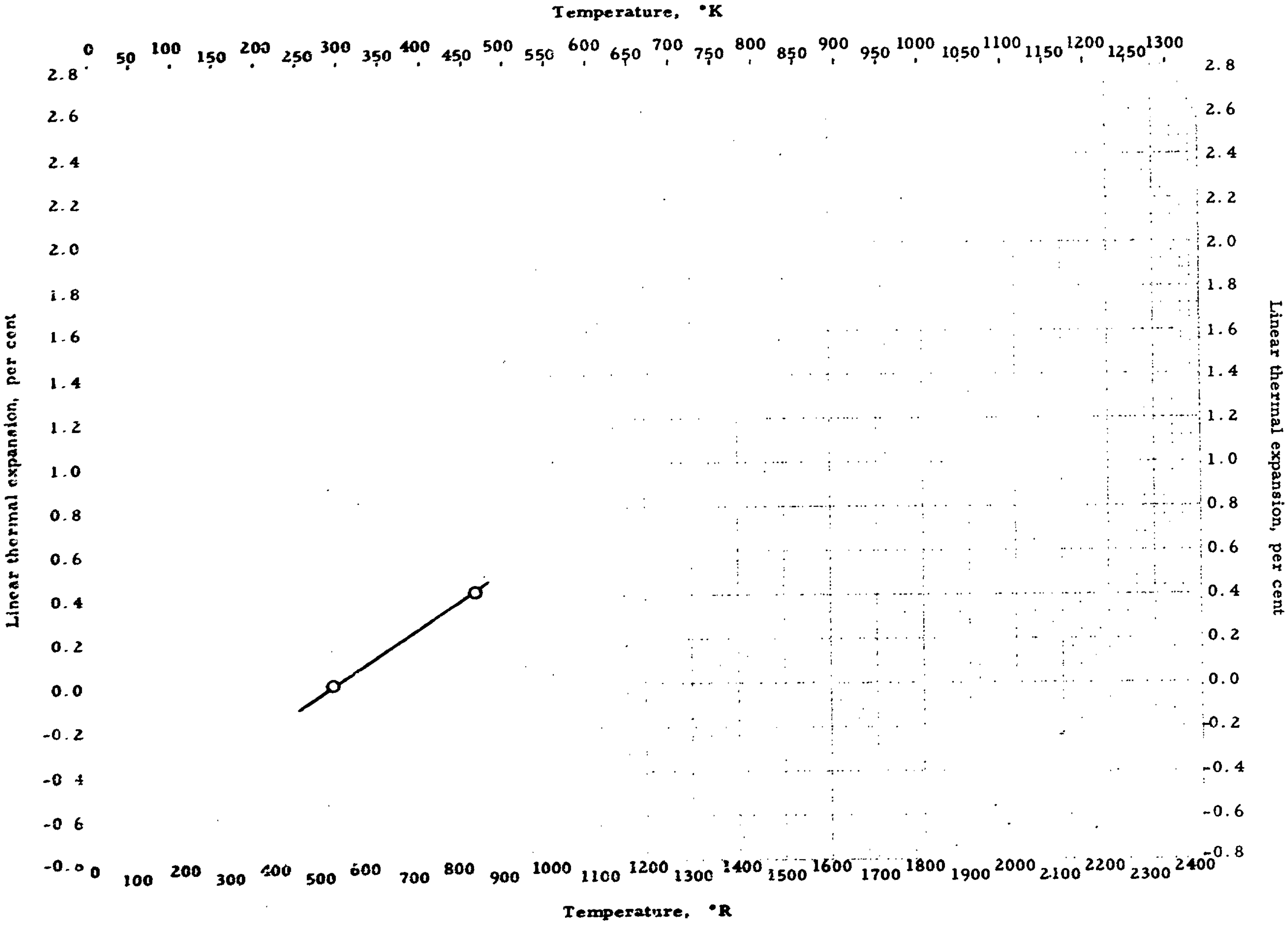


LINEAR THERMAL EXPANSION -- URANIUM + IRON

LINEAR THERMAL EXPANSION -- URANIUM + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Massachusetts Inst. of Technology	53-126	540-1734	10.7% Fe; 0.0335% C	Quartz tube dilatometer with differential transformer pickup	Cast at 5 - 35 µ Hg vac. Meas. by W.C. Paynton and H.F. Sawyer. O - heating ϙ - cooling

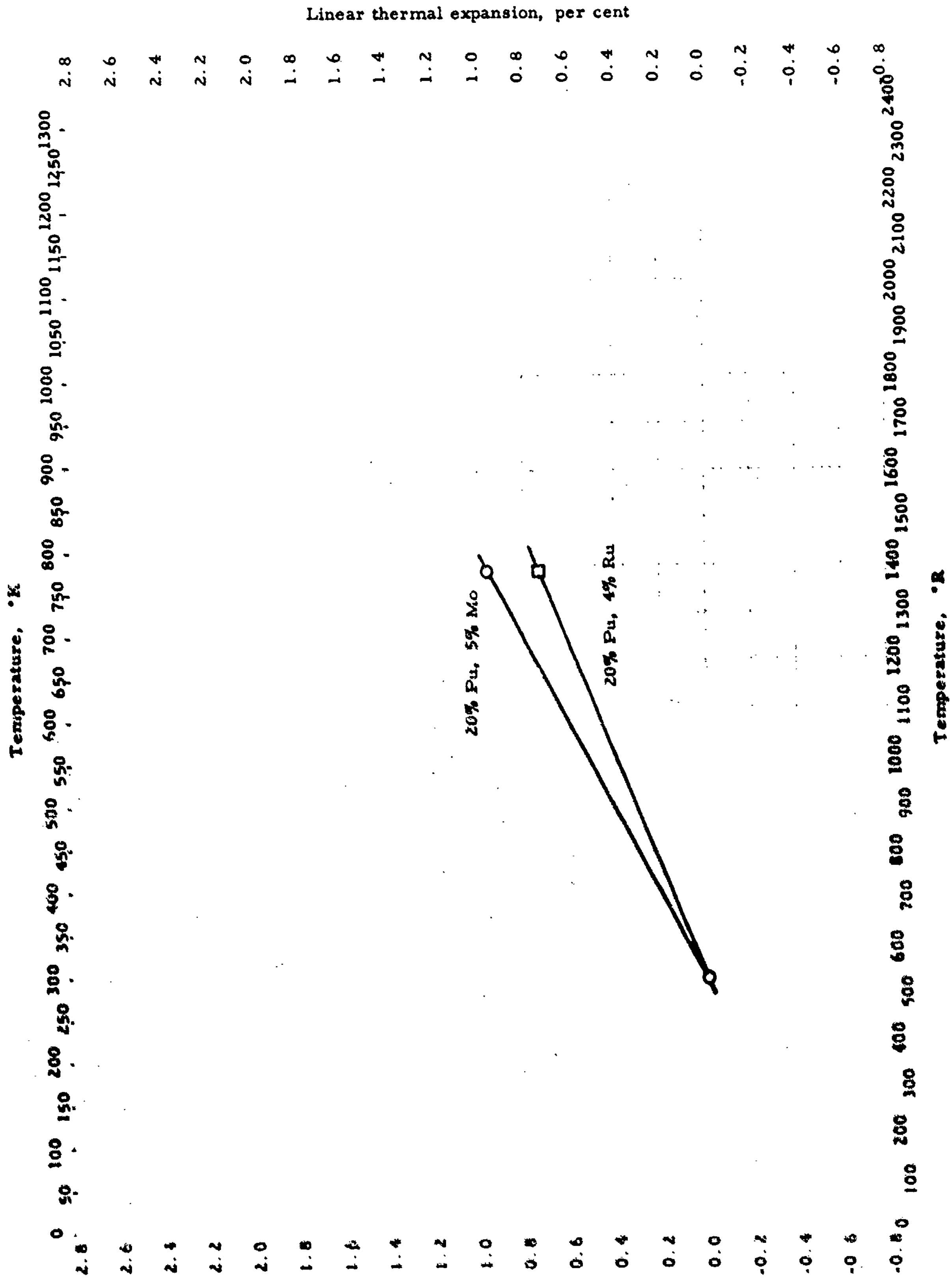


LINEAR THERMAL EXPANSION -- URANIUM + MAGNESIUM

LINEAR THERMAL EXPANSION -- URANIUM + MAGNESIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	McCreight, L. R.	52-119	528-834	71% U; 29% Mg	Gaertner Interferometer in Argon atmosphere	Powders mixed, cold compacted, hot extruded. Meas. parallel to direction of extrusion

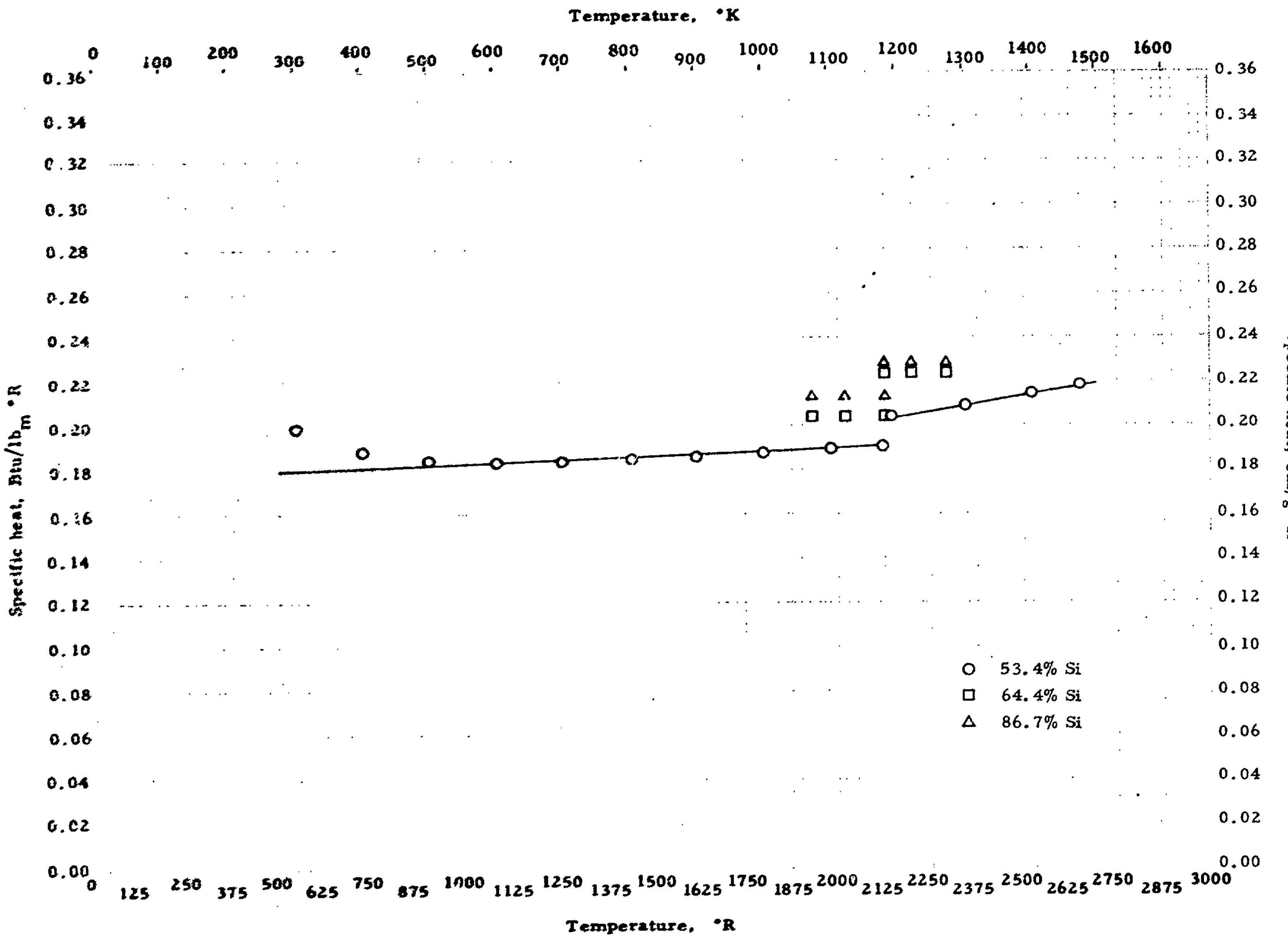


LINEAR THERMAL EXPANSION -- URANIUM + PLUTONIUM + X

LINEAR THERMAL EXPANSION -- URANIUM + PLUTONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Argonne Natl. Laboratory	56-120	1392	20% Pu; 5% Mo	Not given	As cast
□	Ibid.	56-120	1392	20% Pu; 4.3% Ru; 2.8% Mo; 2.5% Pd; 0.7% Rh; 0.5% Zr	Same as above	Same as above

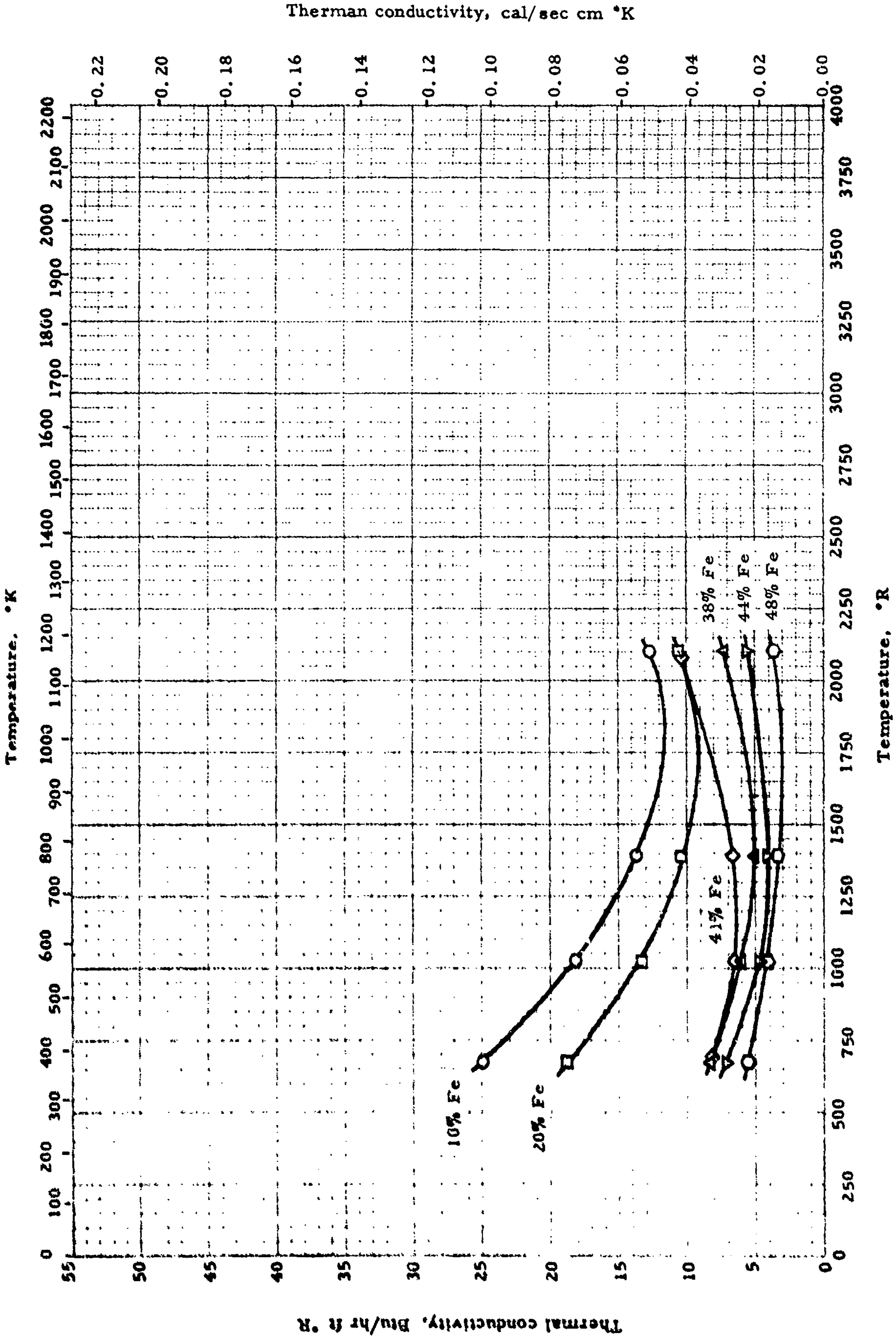


SPECIFIC HEAT -- SILICON + IRON

SPECIFIC HEAT -- SILICON + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Serebrennikov, N.N. and Gel'd, P. V.	54-67	540-2651	53.4% Si; prepared from Armco iron and 99.2% pure Si	Drop method; copper block calorimeter	Annealed 3 hr at 700 °C
□	Ibid.	54-67	1932-2292	64.37% Si; raw materials same as above	Same as above	Same as above
△	Ibid.	54-67	1932-2292	86.73% Si; raw materials same as above	Same as above	Same as above

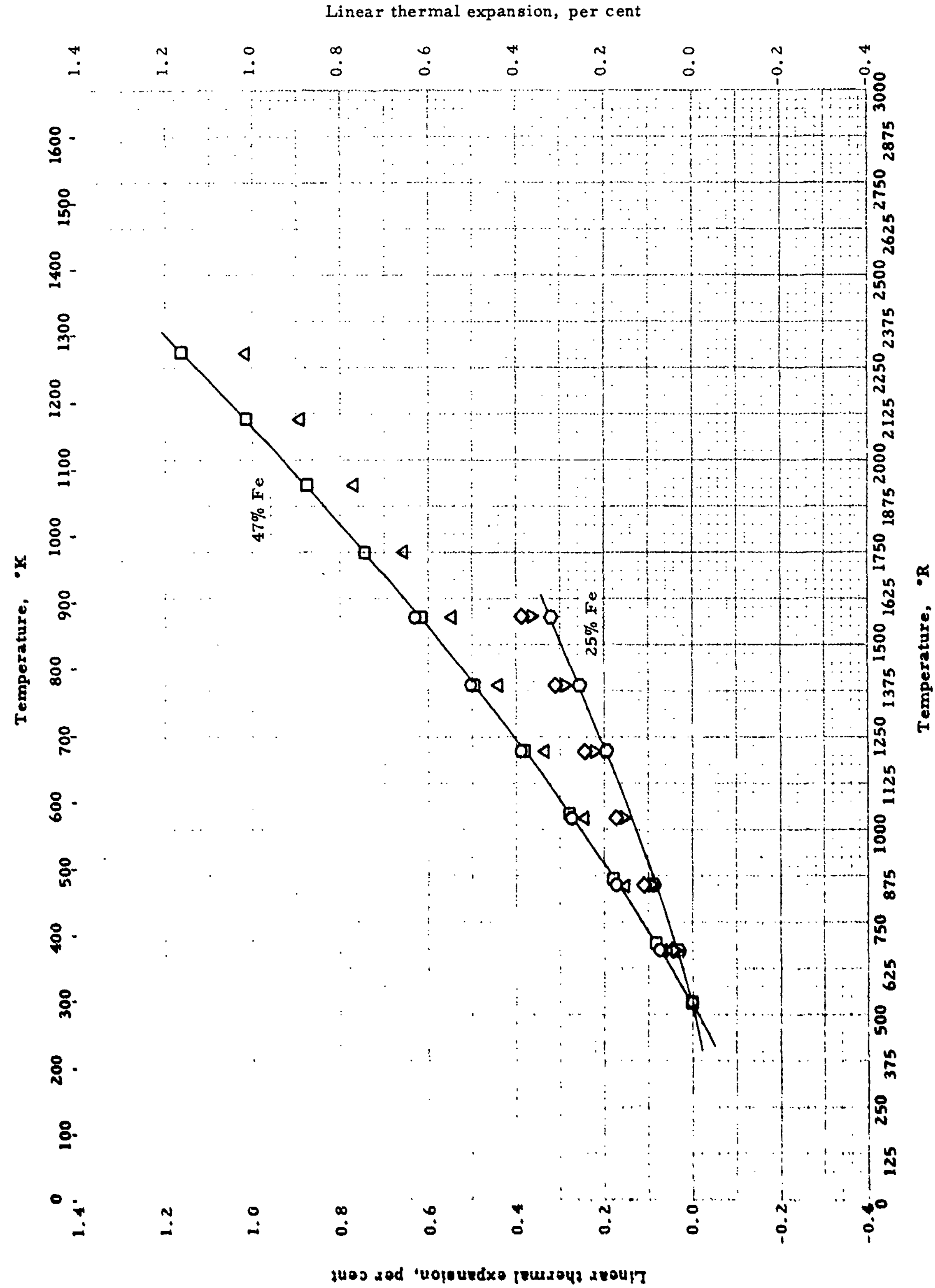


THERMAL CONDUCTIVITY -- SILICON + IRON

THERMAL CONDUCTIVITY - - SILICON + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Kuprovsky, B.B. and Gel'd, P.V.	56-106	672-2112	90% Si; 10% Fe	Radial heat flow in cylinder	Auth. est. accuracy ± 7%
□	Ibid.	56-106	672-2112	80% Si; 20% Fe	Same as above	Same as above
△	Ibid.	56-106	672-2112	62% Si; 38% Fe	Same as above	Same as above
◇	Ibid.	56-106	672-2112	59% Si; 41% Fe	Same as above	Same as above
▽	Ibid.	56-106	672-2112	55.5% Si; 44.5% Fe	Same as above	Same as above
○	Ibid.	56-106	672-2112	52.5% Si; 47.5% Fe	Same as above	Same as above

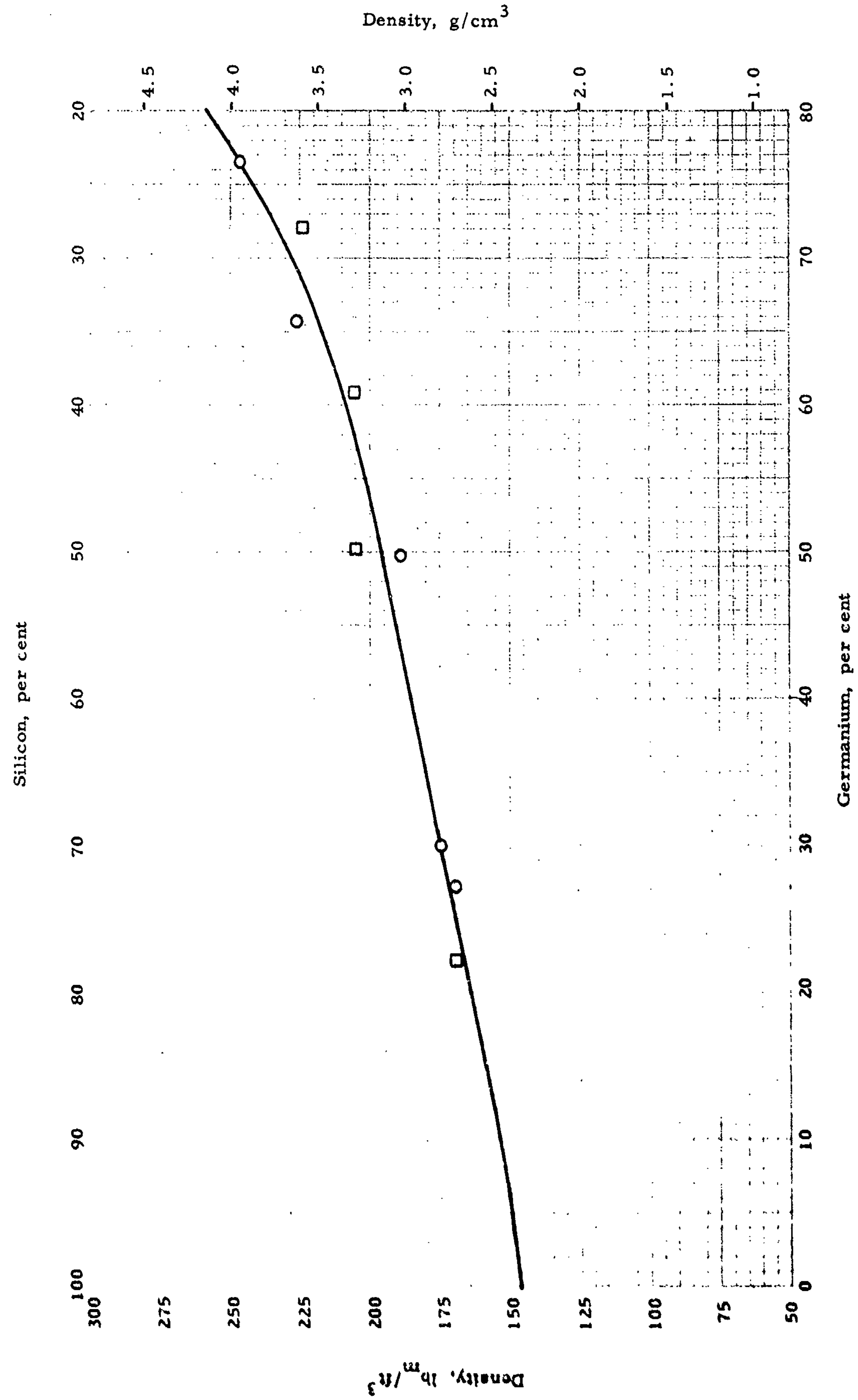


LINEAR THERMAL EXPANSION -- SILICON + IRON

LINEAR THERMAL EXPANSION -- SILICON + IRON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Gel'd, ..., Serebrennikov, N. N. and Sukharev, P. M.	56-39	672-1572	50.20% Si; 49.8% Fe	Dilatometer	Annealed
□	Ibid.	56-39	672-2292	Leboite. 53.38% Si; 46.62% Fe; α-phase	Same as above	Tempered from 950°C
△	Ibid.	56-39	672-2292	Same as above. β-phase	Same as above	Annealed at 800°C
◇	Ibid.	56-39	672-1572	58.11% Si; 41.89% Fe	Same as above	Annealed
▽	Ibid.	56-39	672-1572	68.56% Si; 31.44% Fe	Same as above	Same as above
○	Ibid.	56-39	672-1572	75.03% Si; 24.97% Fe	Same as above	Same as above

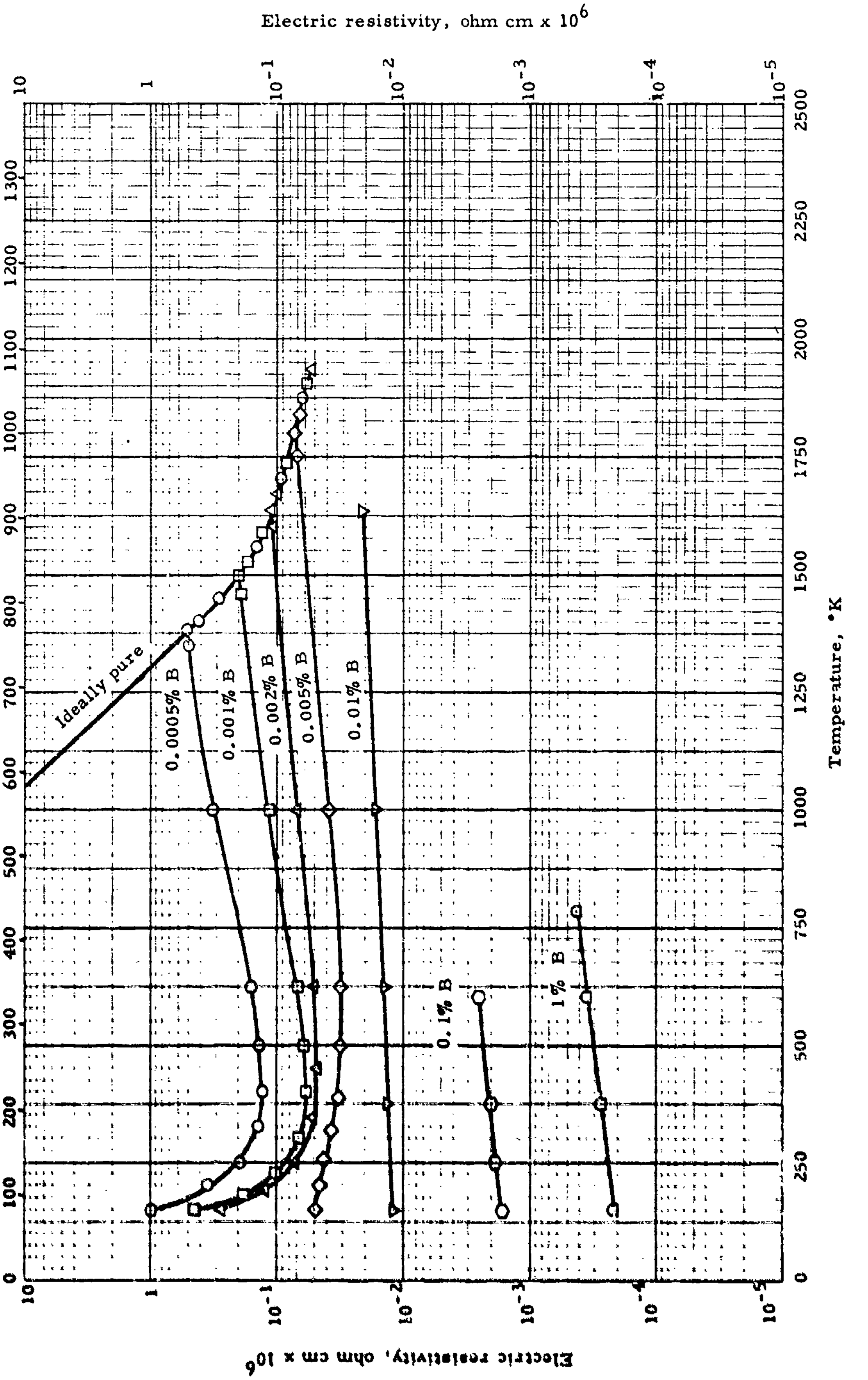


DENSITY -- SILICON + GERMANIUM

DENSITY -- SILICON + GERMANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Johnson, E.R. and Christian, S.M.	54-86	Room	27 - 76% Ge	Not given	Author claims accuracy within a few per cent
□	Wang, C. C.	55-49	Room	22 - 72% Ge; polycrystalline P type	Not given	Prepared by isothermal solidification using zone purfied germanium and hyperpure silicon; alloys were homogeneous

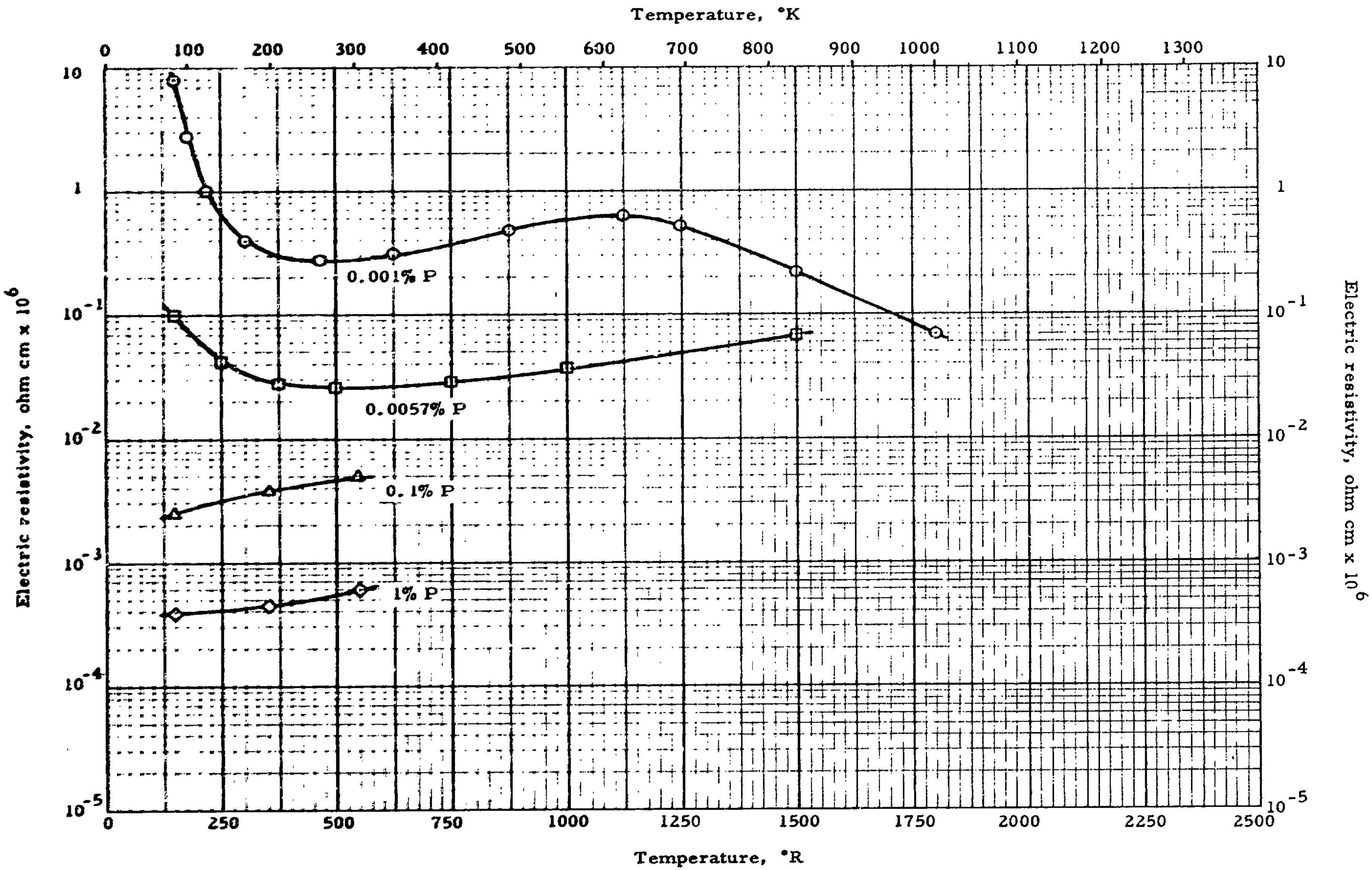


ELECTRIC RESISTIVITY -- SILICON + BORON

ELECTRIC RESISTIVITY -- SILICON + BORON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
◌	Pearson, G. L. and Bardeen, J.	49-4	150-1800	0.0005% B	Potential drop, sample temp. by Chromel-Alumel thermocouple	Auth. est. $r = 10^6$ ohm cm for ideally pure Si at room temp.
□	Ibid.	49-4	150-1800	0.001% B	Same as above	Same as above
△	Ibid.	49-4	150-1800	0.002% B	Same as above	Same as above
◇	Ibid.	49-4	150-1800	0.005% B	Same as above	Same as above
▽	Ibid.	49-4	150-1640	0.01% B	Same as above	Same as above
○	Ibid.	49-4	150-600	0.1% B	Same as above	Same as above
◠	Ibid.	49-4	150-783	1% B	Same as above	Same as above

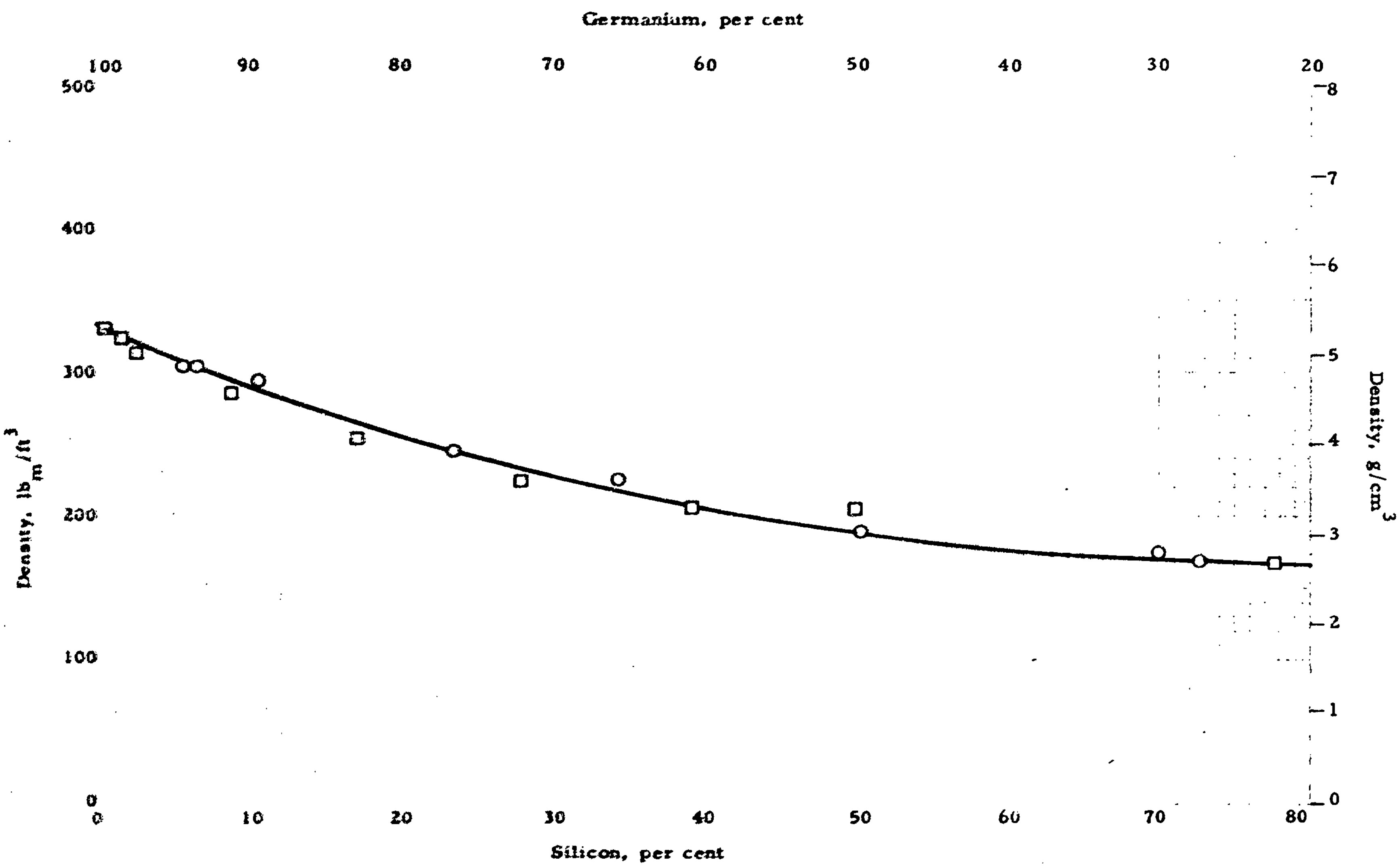


ELECTRIC RESISTIVITY -- SILICON + PHOSPHORUS

ELECTRIC RESISTIVITY -- SILICON + PHOSPHORUS

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pearson, G. L. and Bardeen, J.	49-4	150-1800	0.001% P	Potential drop. Temp. by Chromel-Alumel thermocouple	Auth. est. resistivity at room temp. of pure Si to be 10^{-6} ohm cm
□	Ibid.	49-4	150-1500	0.0057% P	Same as above	Same as above
△	Ibid.	49-4	150-546	0.1% P	Same as above	Same as above
◇	Ibid.	49-4	150-600	1% P	Same as above	Same as above

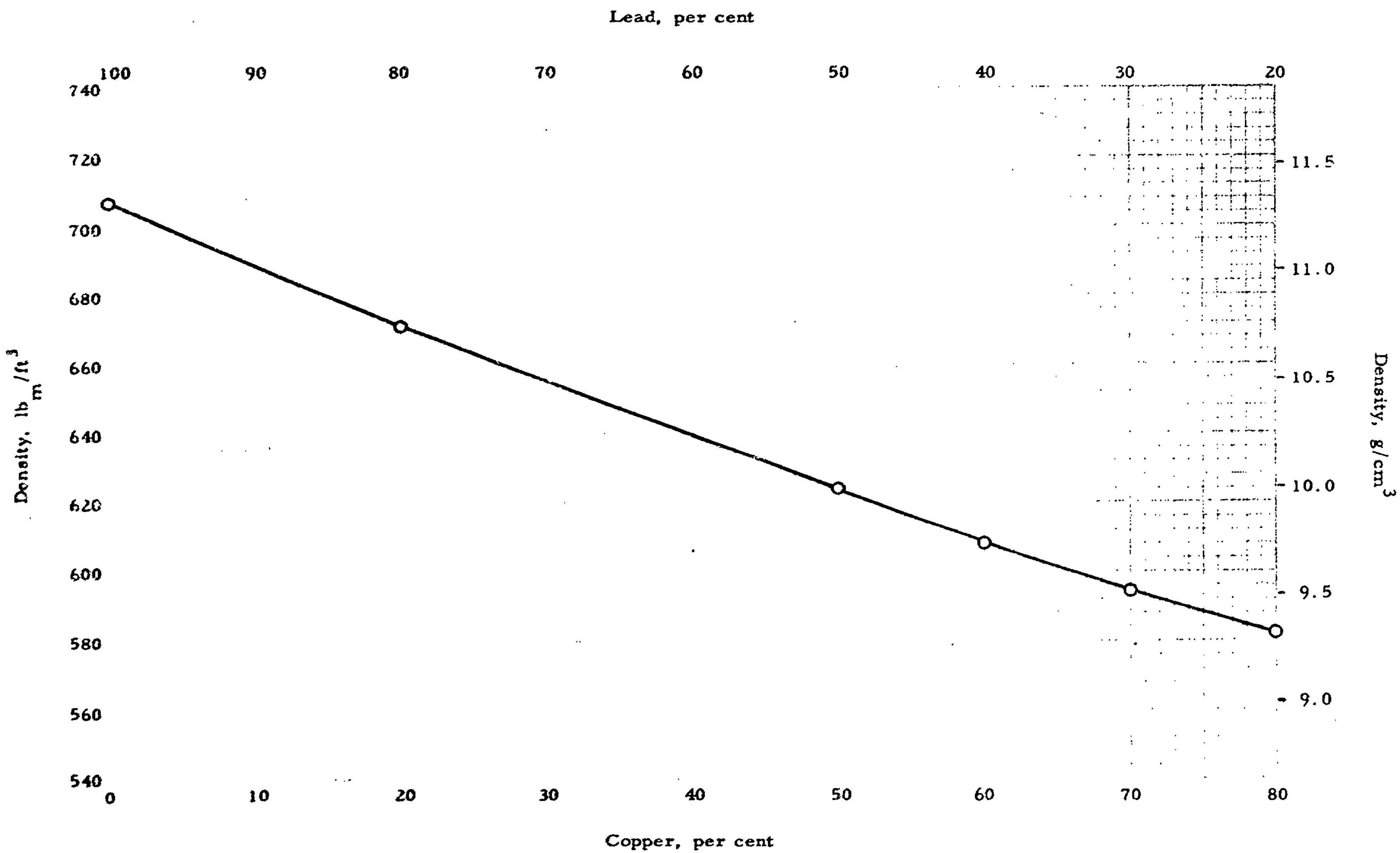


DENSITY -- GERMANIUM + SILICON

DENSITY -- GERMANIUM + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Johnson, E.R. and Christian, S.M.	54-86	Room	Binary alloy series 5-73% Si	ρ: not given	Auth. claim accuracy of a few per cent
□	Wang, C.C.	55-49	Room	Binary alloy series 0.4-78% Si; from zone purified Ge and hyper-pure Si	ρ: not given	Prepared by isothermal solidification into homogeneous alloys

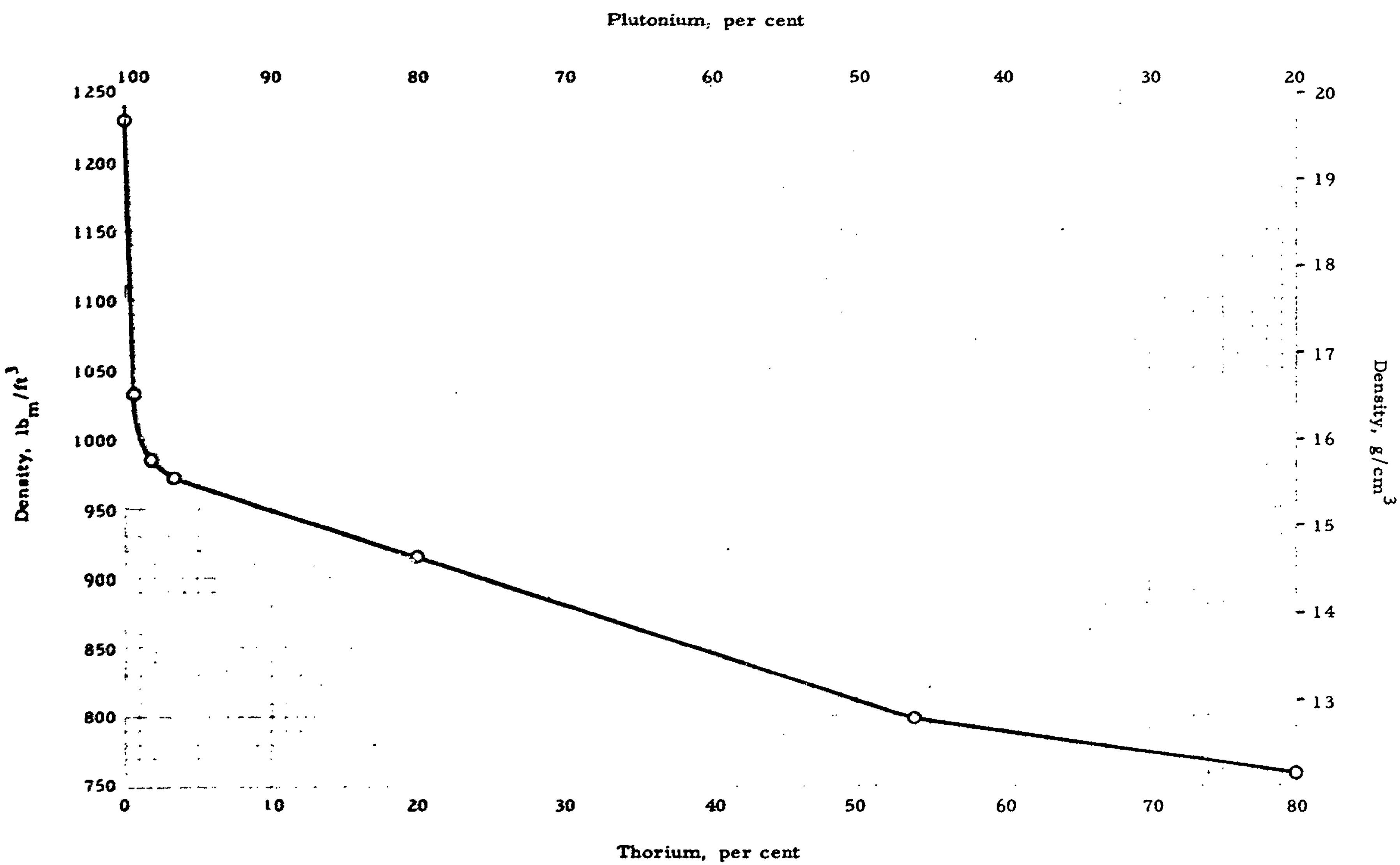


DENSITY -- LEAD + COPPER

DENSITY -- LEAD + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Pelzel, E.	57-80	Room	0 - 80% Cu	Weight in air and in water	



DENSITY -- PLUTONIUM + THORIUM

DENSITY -- PLUTONIUM + THORIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Poole, D. M., Williamson, G. K. and Marples, J. A. C.	57-75 also 57-16	540	Alloy series: 0 - 80% Th	ρ: weight in air, in water, and in ethylene bromide	As cast

Symbol	Composition	Density lb_m/ft^3	Density g/cm^3
○	Rh_3Ge_4	531	8.5
□	$RhGe$	612	9.8
△	Rh_5Ge_3	668	10.7
◇	Rh_2Ge	687	11.0

DENSITY -- RHODIUM + GERMANIUM

DENSITY -- RHODIUM + GERMANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Zhuravlev, N. N. and Zhdanov, G. S.	56-67	Room	Rh_3Ge_4. 48.47% Ge	ρ: weight in air and CCl_4	Alloyed in high frequency furnace with A atm. in quartz ampules
□	Ibid.	56-67	Room	Rh Ge. 41.36% Ge	ρ: same as above	Same as above
△	Ibid.	56-67	Room	Rh_5Ge_3. 29.74% Ge	ρ: same as above	Same as above
◇	Ibid.	56-67	Room	Rh_2 Ge. 26.07% Ge	ρ: same as above	Same as above

PROPERTIES OF BISMUTH + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density U_3Bi_4	786 lb_m/ft^3	12.6 g/cm^3
Melting Point U_3Bi_4 . .	2560 °R	1220 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:

	lb_m/ft^3	g/cm^3	Material Composition
○	772.9	12.38	UBi_2
□	780.6	12.59	U_3Bi_4
△	849	13.6	UBi
▽	771.0	12.35	UBi_2
⬡	786.0	12.59	U_3Bi_4
◇	719.2 ± 12	11.52 ± 0.2	U_4Bi_5

Melting Point:

	°R	°K	
○	2310	1283	UBi_2
□	2562	1423	U_3Bi_4
△	3057 ± 45	1425 ± 25	UBi

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF BISMUTH + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Teitel, R. J.	57-161	2310 Room	UBi_2	MP: break in time-temp.curve; Chromel-Alumel thermocouple ρ: not given	Made from 99.99% Bi and U dissolved in nitric acid via the hydride
□	Ibid.	57-161	Room 2562	U_3Bi_4	ρ: same as above MP: same as above	Same as above
△	Ibid.	57-161	Room 3012-3102	UBi_2	ρ: same as above MP: same as above	Same as above
◇	Brewer, L., Edwards, R.K. and Templeton, D.H.	49-56	Room	U_4Bi_5	ρ: computed from x-ray measurements of lattice	Prepared from 99.9+% U and 99.8% Bi mixed, degassed 20 min. up to 1130°C; 40 min. up to 1500°C
▽	Ferro, R.	52-125 also 53-132	Room	UBi_2	ρ: computed from x-ray measurements of lattice	
○	Ibid.	52-125 also 53-132	Room	U_3Bi_4	ρ: same as above	

PROPERTIES OF CADMIUM + SILVER

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point	1558°R *	865°K *
Heat of Fusion	32.8 Btu/lb_m *	18.2 cal/g *
Heat of Vaporization . . .		
Heat of Sublimation . . .		

*Value for 68.4% Cd.

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	1558	865
Heat of Fusion:		Btu/lb_m	cal/g
	O	32.8 ± 1.6	18.2 ± 1
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF CADMIUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubaschewski, O.	43-13	1558	68.4% Cd; ϵ phase	MP: not given Δh_f: from enthalpy data by drop method copper block calorimeter	Δh_f: auth. est. accuracy $\pm$ 2.3%

PROPERTIES OF LEAD + PLUTONIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point $PuPb_3$ . .	2010 °R	1120 °K
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	2013	1118
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF LEAD + PLUTONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Konobeeyskii, S. T.	55-94	2013	$PuPb_3$	MP: break in time-temp. curve	

PROPERTIES OF LEAD + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density UPb	855 lb_m/ft^3	13.7 g/cm^3
Melting Point UPb . . .	2800 °R	1550 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	O	855	13.7
	□	827	13.24
	△	810	12.98
Melting Point:		°R	°K
	O	2796	1553
	□	2688	1493
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF LEAD + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Teitel, R. J.	56-130	2688-2796 Room	UPb: 53.5% U; 46.5% Pb	MP: break in time-temp curve ρ: computed from x-ray meas. of lattice	Layers of U and Pb out-gassed at 100 °C, heated in H_2 atm. at 250 °C to convert U into UH_3 powder, then evacuated to decompose UH_3 into U powder, and mixture heated 16 hr. at 1220 °C
□	Frost, B. R. T. and Maskrey, J. T.	54-123	Room 2796	UPb_3: 72.3% Pb; 27.7% U	ρ: not given MP: not given	
△	Teitel, R. J.	52-124	Room	UPb_3: 72.3% Pb; 27.7% U	ρ: not given	

PROPERTIES OF OSMIUM + PLUTONIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density $PuOs_2$	1200 lb_m/ft^3	19.2 g/cm^3
Melting Point $PuOs_2$ . .	3200 °R	1730 °K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:	O	1199	19.2

		°R	°K
Melting Point:	O	3192+	1723+

Heat of Fusion: Btu/lb_m cal/g

Heat of Vaporization: Btu/lb_m cal/g

Heat of Sublimation: Btu/lb_m cal/g

PROPERTIES OF OSMIUM + PLUTONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Konobeeyskii, S. T.	55-94	Room 3192	$PuOs_2$	ρ : computed from X-ray measurements of lattice MP : break in time - temp curve	

PROPERTIES OF PLUTONIUM + OSMIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 3% Os	1140 lb_m/ft^3	18.3 g/cm^3
Melting Point 3% Os . .	1480 °R *	820 °K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11).

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	1140	18.3
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF PLUTONIUM + OSMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Konobeeyskii, S. T.	55-94	Room	3% Os, eta phase	ρ: not given	

PROPERTIES OF PLUTONIUM + X

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density $PuFe_2$	786 lb_m/ft^3	12.6 g/cm^3
Melting Point $PuFe_2$.	2700°R	1500°K
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

REPORTED VALUES

		lb_m/ft^3	g/cm^3
Density:			
	○	1068	17.1
	□	785.0	12.59
	△	749	12.0
Melting Point:		°R	°K
	□	2706	1503
	△	2382	1323
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF PLUTONIUM + X

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Konobeeyskii, S. T.	55-94	Room	Pu_6Fe	ρ : computed from X-ray measurements of lattice	
□	Ibid.	55-94	Room 2706	$PuFe_2$	ρ : Same as above MP : break in time-temp curve	
△	Ibid.	55-94	Room 2382	$PuMn_2$	ρ : same as above MP : same as above	

PROPERTIES OF RHENIUM + TUNGSTEN

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point	5550°R *	3080°K *
Heat of Fusion		
Heat of Vaporization. . .		
Heat of Sublimation . . .		

*33% W

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	5550	3083
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF RHENIUM + TUNGSTEN

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Sims, C.T., Craighead, C.M. and Jaffee, R.	55-59	5550	33% W	MP: collapse of hole; calibrated optical pyrometer sighting on black body cavity	Auth. call this the lowest melting eutectic for the whole Re-W system

PROPERTIES OF TIN + URANIUM

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density 60% Sn	620 lb_m/ft^3	9.95 g/cm^3
Melting Point 60% Sn .	2920 °R *	1620 °K *
Heat of Fusion		
Heat of Vaporization . . .		
Heat of Sublimation . . .		

* Constitution of Binary Alloys (Ref. 58-11)

REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
	O	621	9.95
Melting Point:		°R	°K
Heat of Fusion:		Btu/lb_m	cal/g
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF TIN + URANIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Rundle, R. E. and Wilson, A. S.	47-57	Room	USn_3: 60% Sn; 40% U	ρ: computed from X-ray measurements of lattice	

PROPERTIES OF ZINC + SILVER

MOST PROBABLE VALUES

Property	Brit. Engineering Units	C. G. S. Units
Density.		
Melting Point 61% Zn . .	1630 °R	905 °K
Heat of Fusion 61% Zn .	49 Btu/lb_m	27 cal/g
Heat of Vaporization. . .		
Heat of Sublimation . . .		

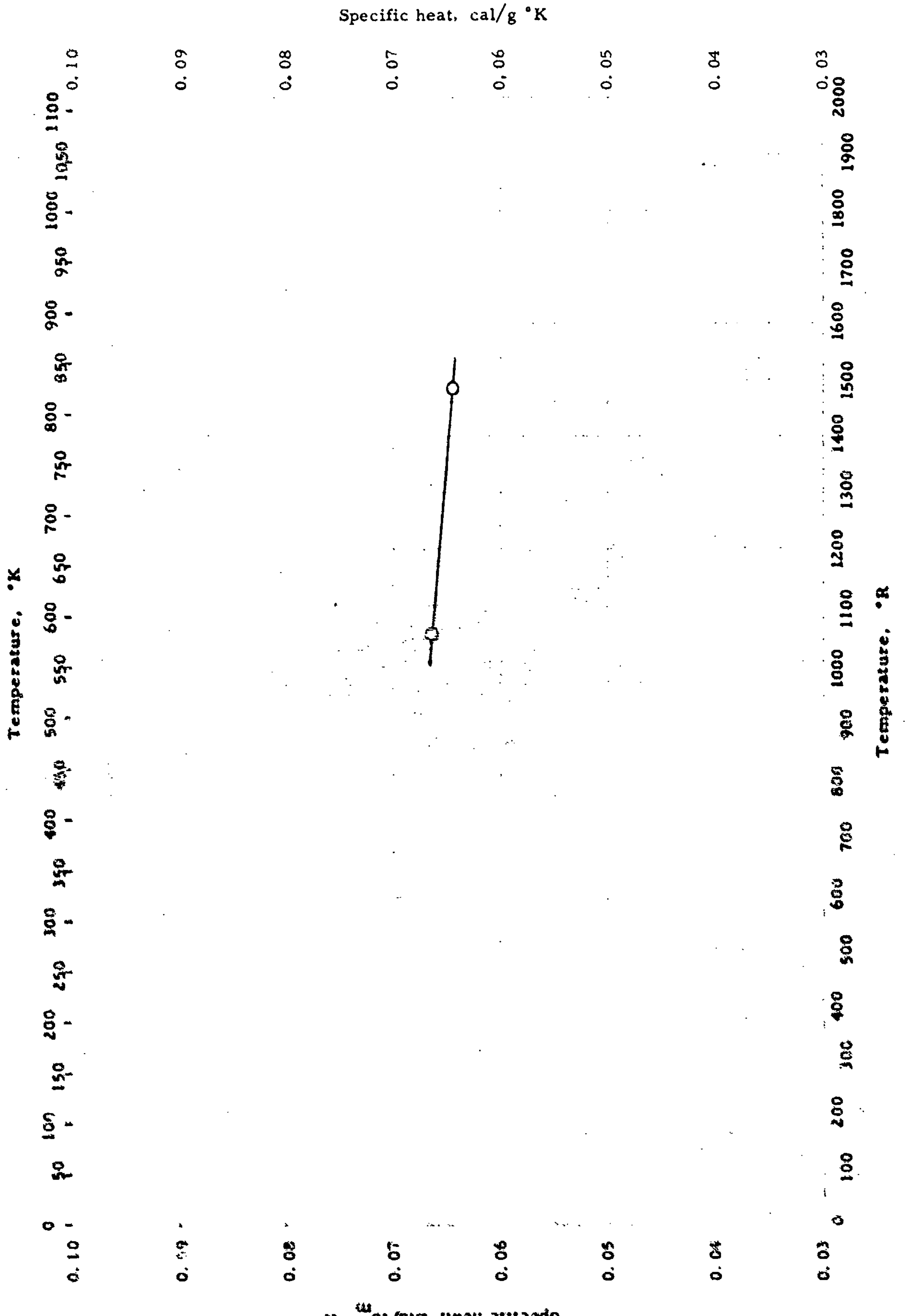
REPORTED VALUES

Density:		lb_m/ft^3	g/cm^3
Melting Point:		°R	°K
	O	1630	905
Heat of Fusion:		Btu/lb_m	cal/g
	O	48.7 ± 2.3	27.1 ± 1.3
Heat of Vaporization:		Btu/lb_m	cal/g
Heat of Sublimation:		Btu/lb_m	cal/g

PROPERTIES OF ZINC + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubaschewski, O.	43-13	1629	61.0% Zn	MP: break in time-temp. curve	ϵ-phase
			1629		ΔH_f: enthalpy difference of solid and liquid meas. in calorimeter	Auth. est. accuracy $\pm$ 2.3% in ΔH_f

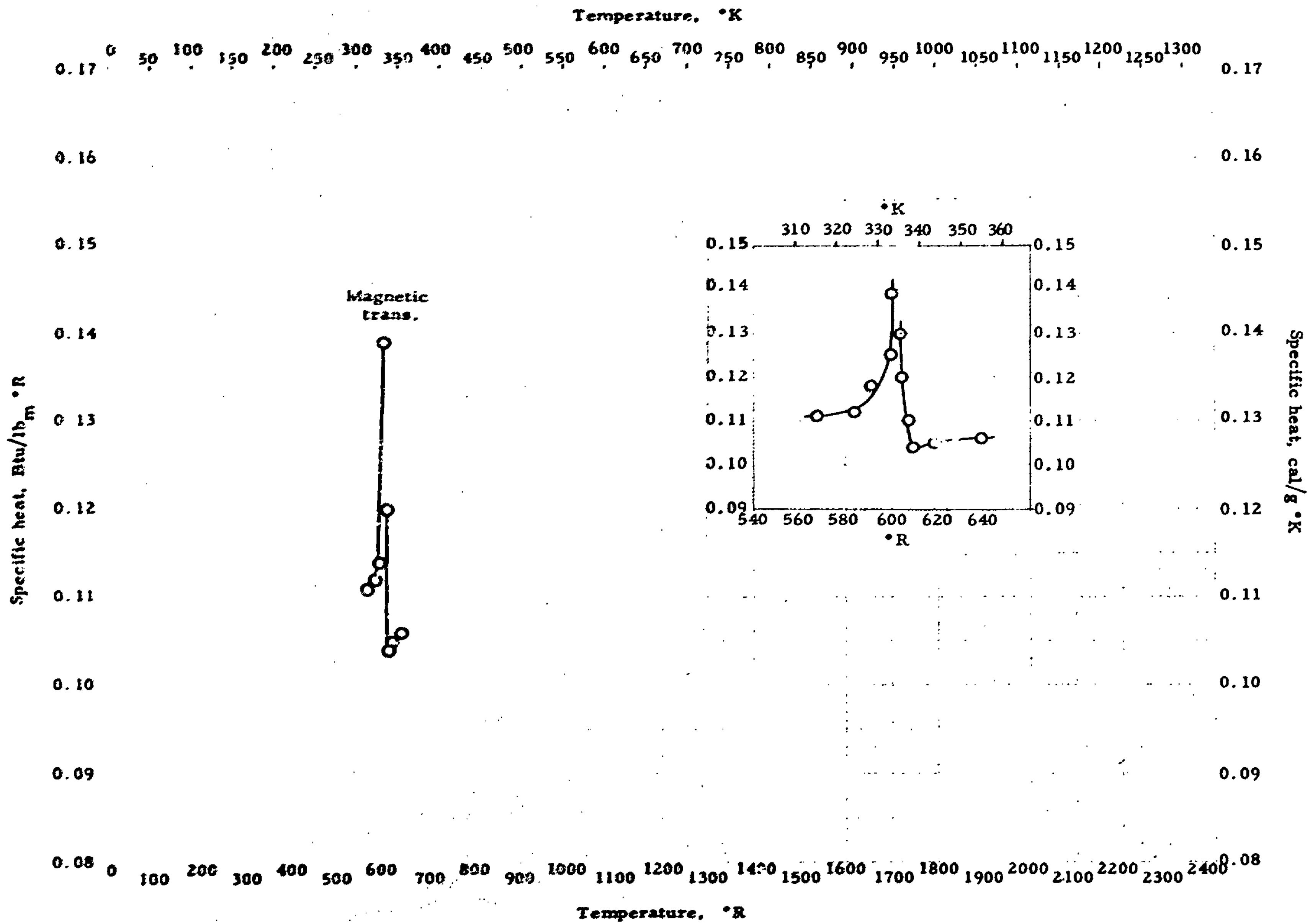


SPECIFIC HEAT -- CADMIUM + SILVER

SPECIFIC HEAT -- CADMIUM + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubaschewski, O.	43-13	1050-1485	68.4% Cd	Drop method	Auth. reports mean c_p. Computed c_p at ARF by fitting linear equation for c_p to enthalpy data

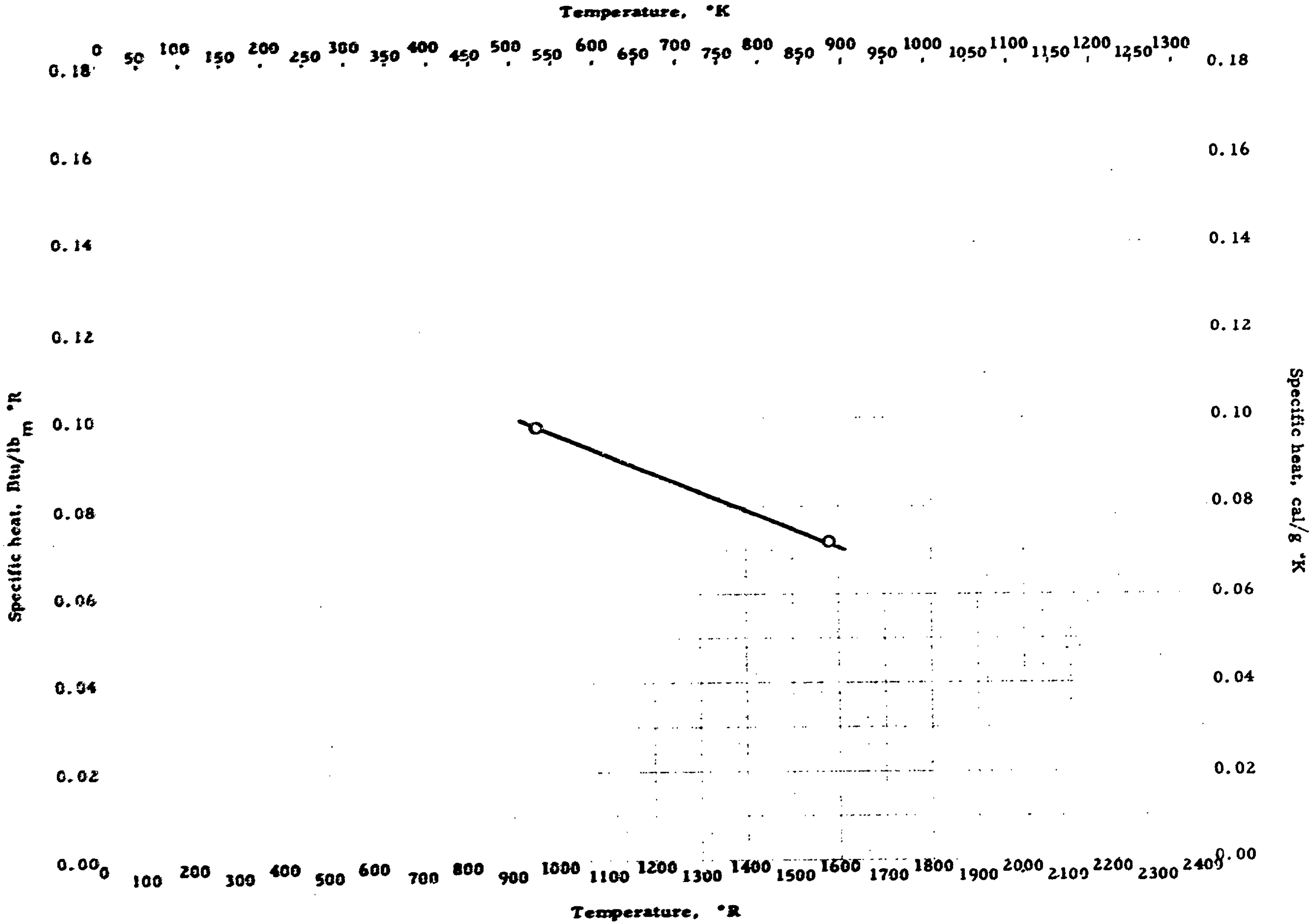


SPECIFIC HEAT -- TELLURIUM + CHROMIUM

SPECIFIC HEAT -- TELLURIUM + CHROMIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kikoin, A. K.	49-24	564-638	75.7% Te; 24.3% Cr	Nernst-Euken type calorimeter	Prepared by fusion of Cr, Te powders at 1200°C in vacuum

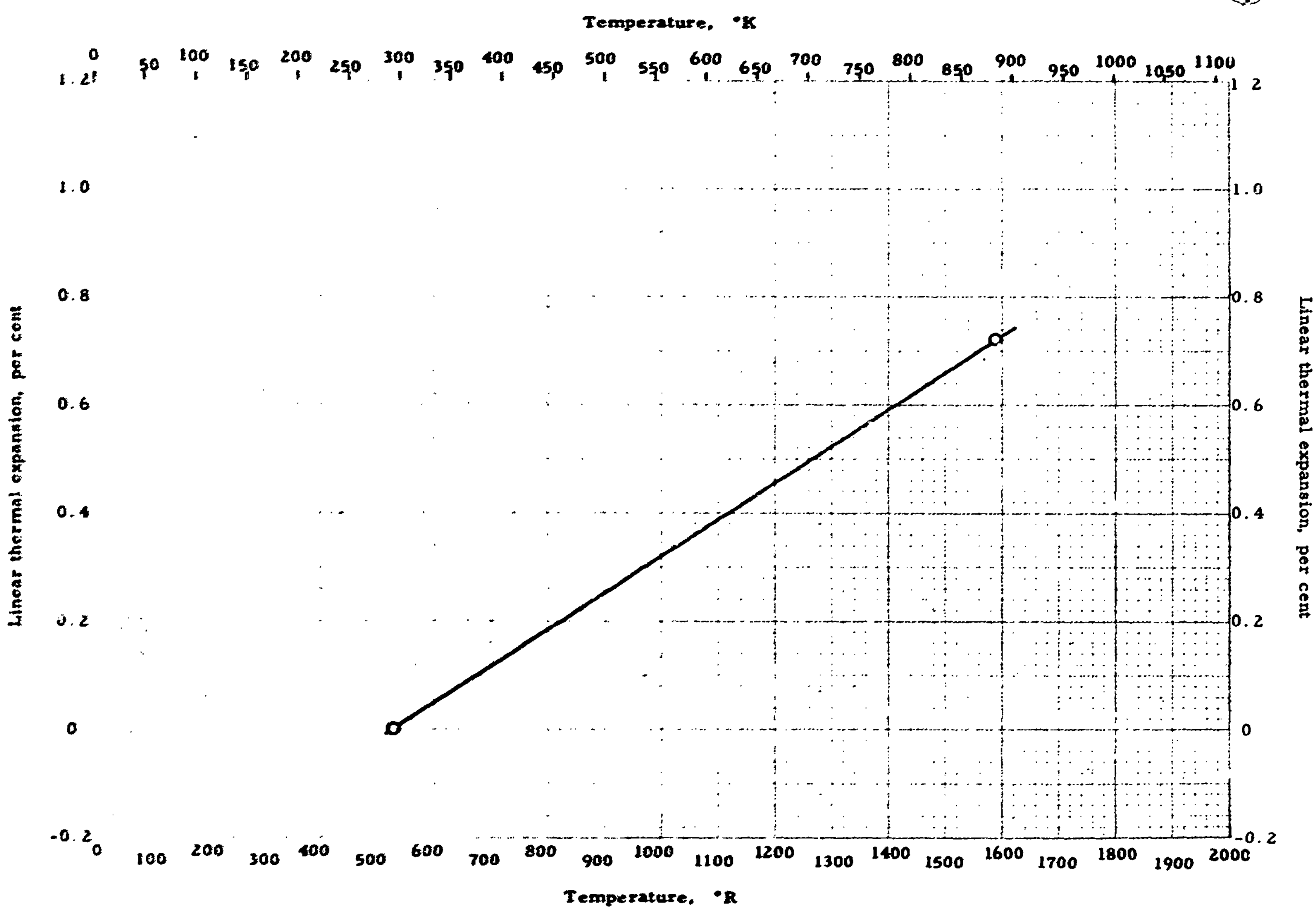


SPECIFIC HEAT -- ZINC + SILVER

SPECIFIC HEAT -- ZINC + SILVER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Kubaschewski, O.	43-13	950-1580	61.0% Zn, ϵ phase	Enthalpy meas. with calorimeter	Auth. est. accuracy $\pm$ 1% Data from least square equation by ARF

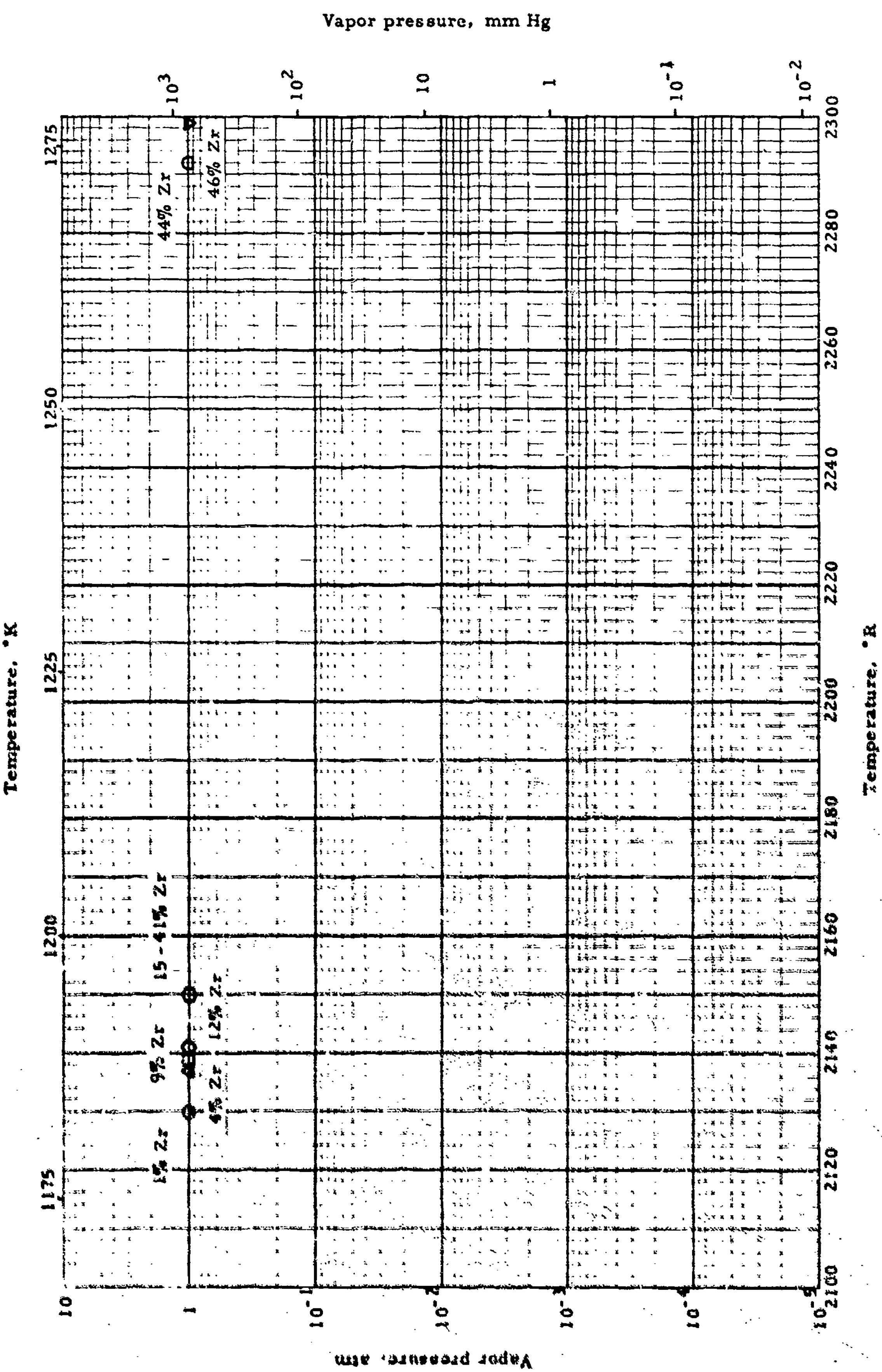


LINEAR THERMAL EXPANSION -- PLUTONIUM + ALUMINUM

LINEAR THERMAL EXPANSION -- PLUTONIUM + ALUMINUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
O	Argonne Natl. Laboratory	56-120	528-1397	1.4% Al	Not given	Tested in as cast condition at 4°C/min. rise

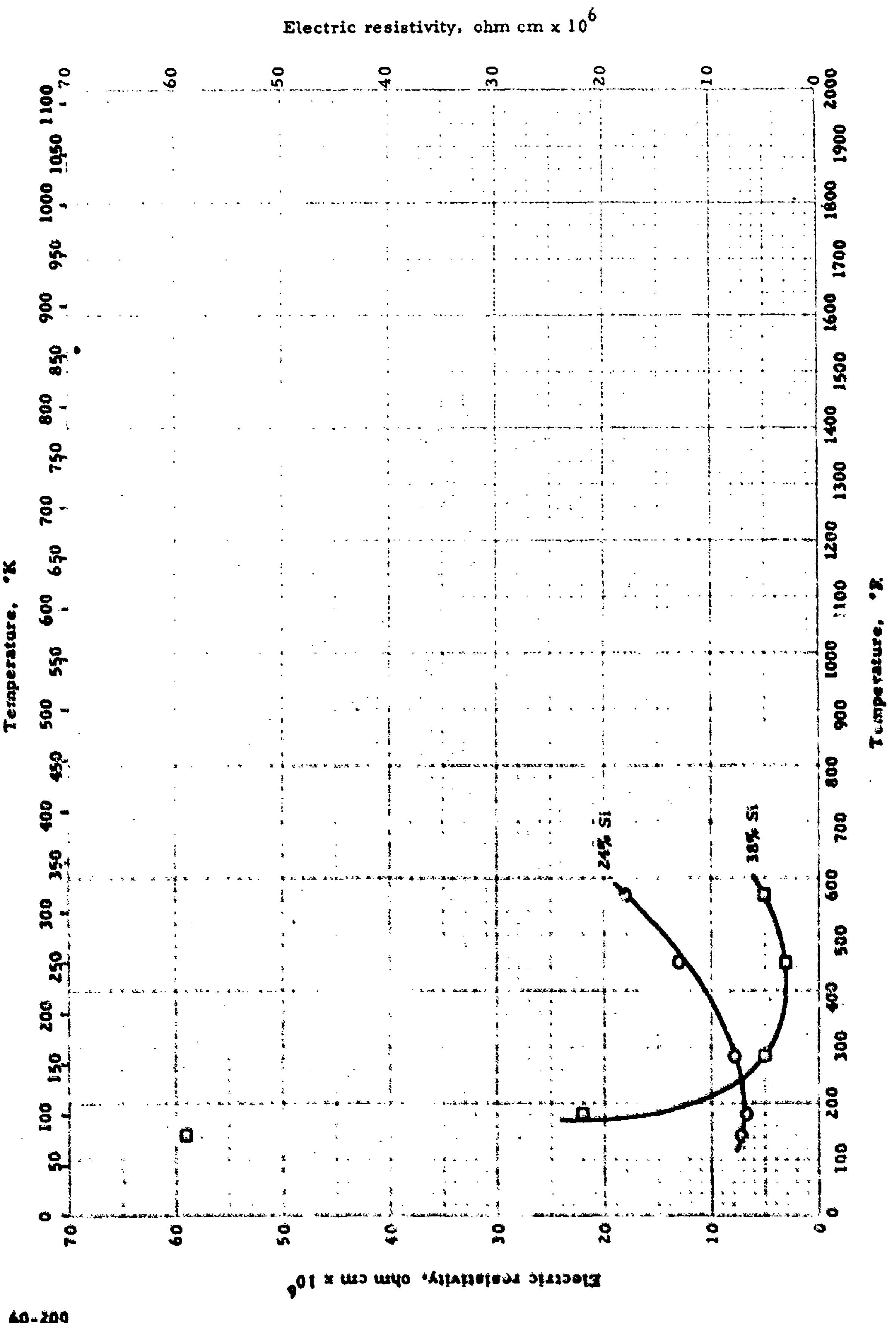


VAPOR PRESSURE -- ZINC + ZIRCONIUM

VAPOR PRESSURE -- ZINC + ZIRCONIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Chiotti, P. and Carlson, O.N.	56-129	2130	1.08% Zr	Dew point method	Meas. temp. at which Zn pressure was 1 atm.
△	Ibid.	56-129	2137	4.0% Zr	Same as above	Same as above
□	Ibid.	56-129	2139	2 alloys: 8.74% Zr and 9.0% Zr	Same as above	Same temp. for both alloys
◇	Ibid.	56-129	2141	12.0% Zr	Same as above	Same as above
○	Ibid.	56-129	2150	4 alloys: 15.0% Zr; 23.73% Zr; 24.7% Zr; 41% Zr	Same as above	Same temp. for the 4 alloys
▽	Ibid.	56-129	2299	44% Zr	Same as above	Same as above
□	Ibid.	56-129	2292	46% Zr	Same as above	Same as above

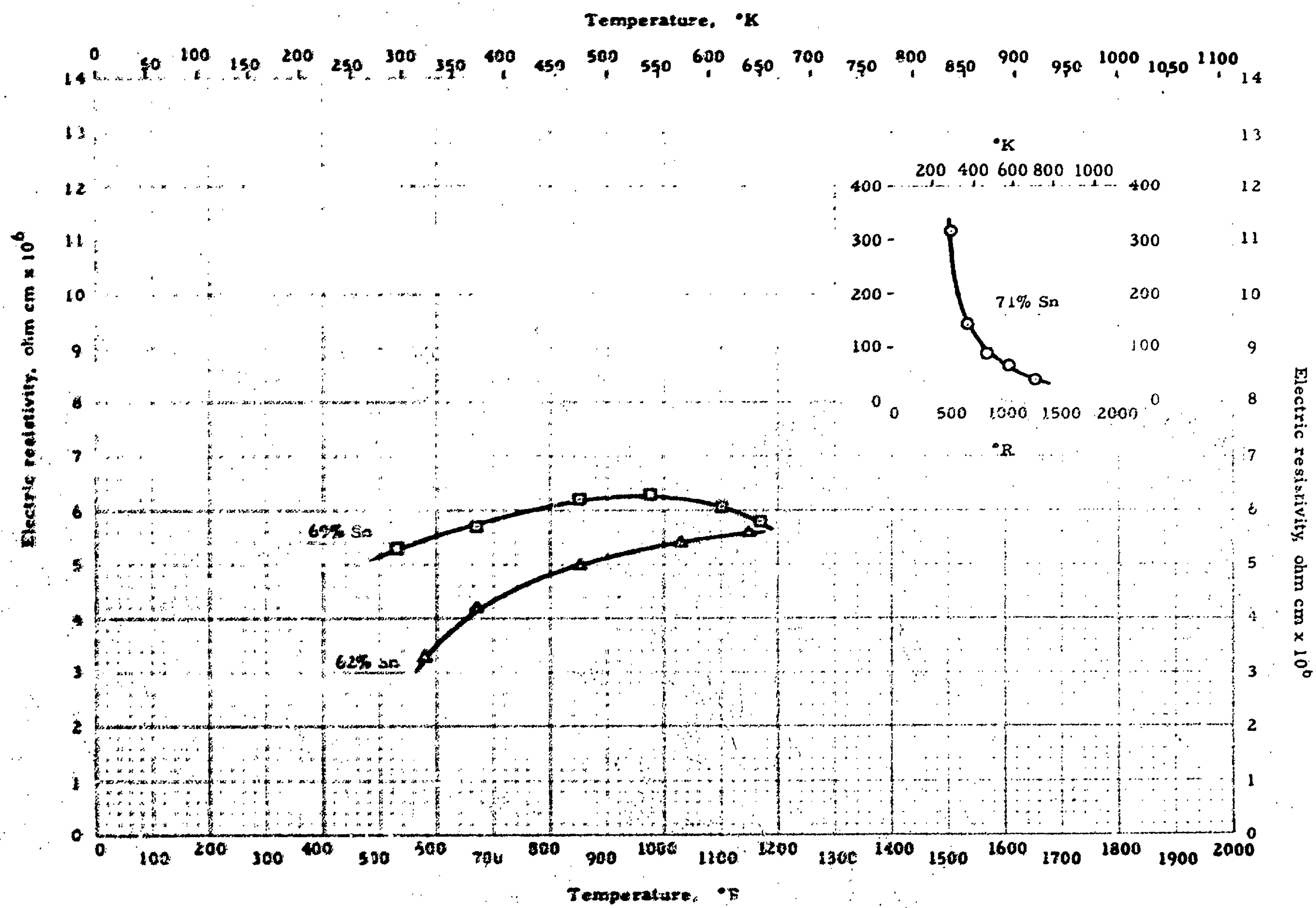


ELECTRIC RESISTIVITY -- GERMANIUM + SILICON

ELECTRIC RESISTIVITY -- GERMANIUM + SILICON

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Levitas, A.	55-88	142-569	76% Ge; 24% Si	Potential drop	
□	Ibid.	55-88	142-569	62.3% Ge; 37.7% Si	Same as above	

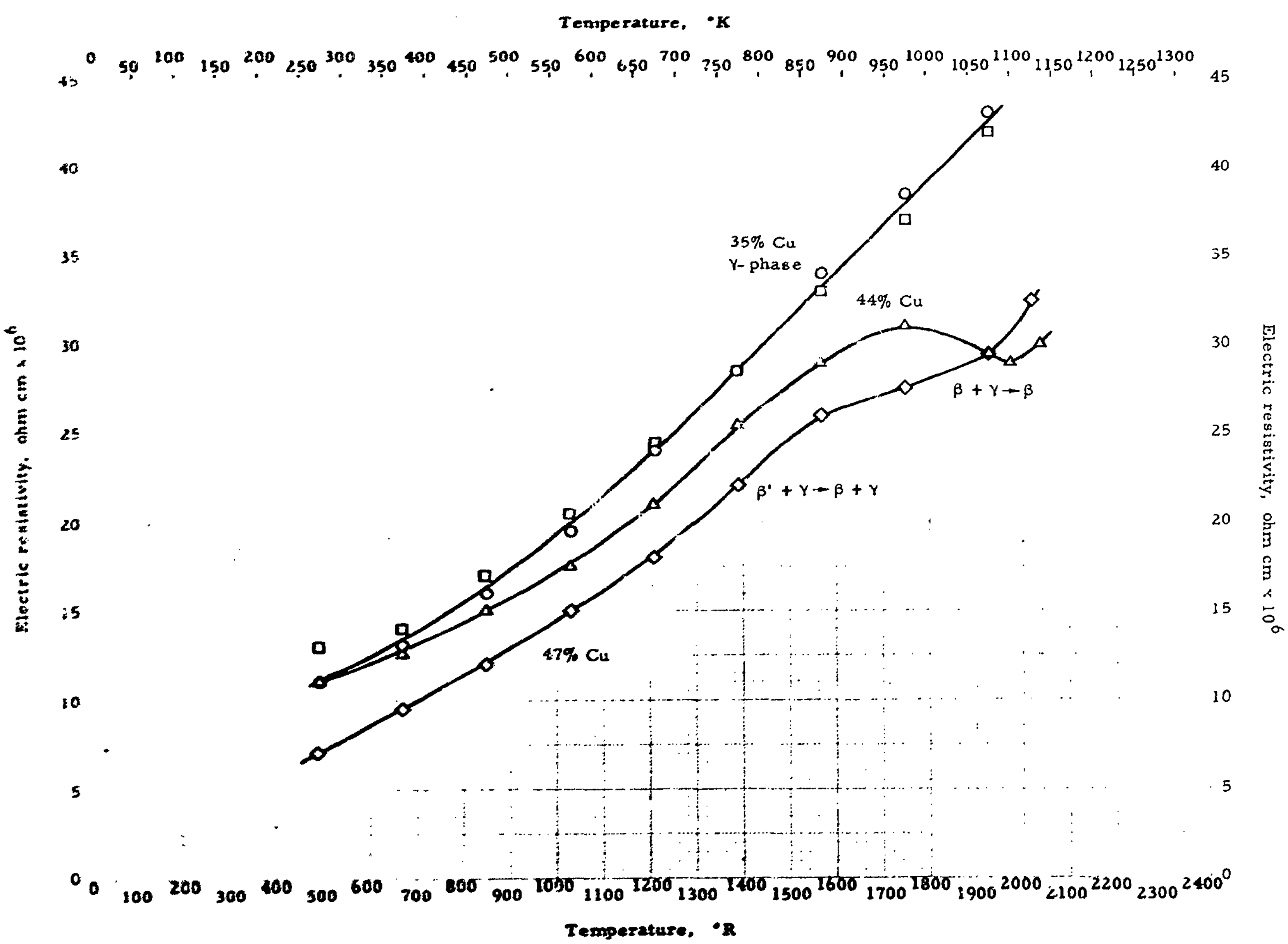


ELECTRIC RESISTIVITY -- TIN + MAGNESIUM

ELECTRIC RESISTIVITY -- TIN + MAGNESIUM

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Boltaks, B.I.	49-37	528-1266	71.1% Sn; 28.9% Mg	Bridge Method	
□	Ibid.	49-37	528-1167	68.5% Sn; 31.5% Mg	Same as above	
△	Ibid.	49-37	582-1149	62.4% Sn; 37.6% Mg	Same as above	



ELECTRIC RESISTIVITY -- ZINC + COPPER

ELECTRIC RESISTIVITY -- ZINC + COPPER

REFERENCE INFORMATION

Symbol	Investigator	Ref.	Range, °R	Material Composition	Test Method	Remarks
○	Pectjare, O. and Janssen, S.	57-99	492-1932	65% Zn; 35% Cu	Not given	
□	Ibid.	57-99	492-1932	62% Zn; 38% Cu	Same as above	
△	Ibid.	57-99	492-2040	56.5% Zn; 43.5% Cu	Same as above	
◇	Ibid.	57-99	492-2022	53% Zn; 47% Cu	Same as above	

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Armour Research Institute, Chicago, Ill.
THERMOPHYSICAL PROPERTIES OF SOLID MATERIALS. VOLUME II-ALLOYS, by A. Goldsmith, T. E. Waterman and H. J. Hirschhorn. November 1960. 608p. illus. tables (Proj. 7381; Task 73812)(WADC TR 58-476)(Contract AF 33 (616)-5212)

Unclassified Report

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